AN

ENCYCLOPÆDIA

OF

DOMESTIC ECONOMY:

COMPRISING

SUCH SUBJECTS AS ARE MOST IMMEDIATELY CONNECTED WITH HOUSEKEEPING;

AS,

THE CONSTRUCTION OF DOMESTIC EDIFICES, WITH THE MODES OF WARMING, VENTILATING, AND LIGHTING THEM;

A DESCRIPTION OF THE VARIOUS ARTICLES OF FURNITURE;

A GENERAL ACCOUNT OF

THE ANIMAL AND VEGETABLE SUBSTANCES USED AS FOOD,

AND THE METHODS OF PRESERVING AND PREPARING THEM BY COOKING;

MAKING BREAD;

MATERIALS EMPLOYED IN DRESS AND THE TOILET; BUSINESS OF THE LAUNDRY;

DESCRIPTION OF THE VARIOUS WHEEL-CARRIAGES;

PRESERVATION OF HEALTH; DOMESTIC MEDICINES, &c., &c.

BY THOMAS WEBSTER, F.G.S., &c.,

ASSISTED BY

THE LATE MRS. PARKES,

AUTHOR OF "DOMESTIC DUTIES."

FROM THE LAST LONDON EDITION.

WITH NOTES AND IMPROVEMENTS

BY D. MEREDITH REESE, A.M., M.D.,

OF NEW-YORK.

ILLUSTRATED WITH NEARLY ONE THOUSAND ENGRAVINGS.

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PREFACE

BY THE AMERICAN EDITOR.

This invaluable compendium of useful knowledge, on subjects which intimately relate to domestic happiness, treated in a familiar and practical manner, commends itself to the united head of every family as a standard book of reference on the variety of topics which concern our physical nature, each of which is here exhibited with scientific accuracy and in ample detail. The author, or, as he styles himself, the editor of the work, by his official relation to the "Royal Institution of Great Britain for the Application of Science to the Common Purposes of Life," is undoubtedly possessed of singular adaptation for his task, as indeed is manifest in every part of the work. And the very eminent and excellent lady, whose valuable assistance has been secured for certain portions of the book which treat of matters which are specially within the province of her sex, has shown herself to be worthy of the selection by her admirable contributions to the volume. Her son, Dr. Parkes, has furnished the principal portion of the last chapters relating to Domestic Medicine.

The American publishers have been induced thus promptly to undertake its publication by a conviction that such a work is greatly needed, and by the concurrent testimony of several gentlemen of intelligence and distinction to whom it has been submitted for examination. The extraordinary number of engravings which illustrate its various departments, notwithstanding their expense, it has been deemed important to retain, so as to preserve the integrity of the original. Such additional cuts as have become necessary by the introduction of new matter in adapting the work to the United States, have been engraved for this edition, and will be found superadded in different parts of the volume, thus increasing its value above the original British work.

The American editor has undertaken to introduce such additions to numerous parts of the book as seemed to be called for, in order to conform it to the customs, habits, and taste of this country, and render it useful to the purposes of domestic economy as exemplified practically

in America; and while he has seldom felt authorized to abridge or otherwise mutilate the original, although some of it may be uninteresting and almost unintelligible to many of our countrymen, the few omissions being purely and exclusively foreign and of inconsiderable extent, he has not scrupled to criticise and compare the relative peculiarities of British and American manners; and when propriety has dictated it, he has exhibited the grounds of preference for the latter over the former, thus abating somewhat of the English boast in which the authors have sometimes indulged.

The notes and improvements of this edition are brief, though numerous, and are invariably included in brackets, either at the bottom of the page, or at the close of the chapter or section to which they refer. That they may prove acceptable and useful to his countrymen, and increase the practical and utilitarian character of the book, has been the aim of

THE AMERICAN EDITOR.

PREFACE.

Much has been written on various subjects connected with Domestic Economy; and it was the wish of the late Mr. Longman, many years ago, to see collated into one large volume, for the convenience of reference, information useful to persons who have to superintend domestic establishments, but which was then scattered in fragments through thousands of pages. The difficulties attending such a compilation had long prevented its execution, since it was found upon trial that little had been published suited to the advancing state of science.

To conduct such a work became at length the occupation of the present editor, whose task has been to select and arrange the subjects, and to treat them as he best could, consistently with his own views and the limits of the publication. To this labour he has devoted what time he could spare from his professional pursuits during the last ten years, and the work being now completed, it may be proper to inform those to whom he is best known as a geologist what circumstances led the publishers to request him to undertake such a task. He had been educated as an architect, and forty years ago he had been intimately acquainted with Count Rumford, who put him in possession of the principles relating to Domestic Economy, for which he was so deservedly celebrated. He had also been the first officer, in point of time, that was appointed in the "Royal Institution of Great Britain for the Application of Science to the Common Purposes of Life," to the founding of which Count Rumford had so materially contributed. While in that institution, the editor had designed and superintended the building of the Theatre for Lectures and the Chemical Laboratory; and it was his province, during the first years of that establishment, to occupy himself with the subject of warming buildings by the best construction of chimney fireplaces, stoves, and other methods, as well as with ventilating, lighting, and the application of the principles of Count Rumford to the improvement of various useful kinds of apparatus. It was conceived that some of the experience thus acquired might be available in such a work as the present; and that, by incorporating the principal modern improvements in Domestic Economy, the object might, in some degree, be attained.

It may be proper to state the views which have guided the editor throughout the work. Without going into the subject of education, the present state of society, the use and abuse of time, it cannot but

be admitted that it is extremely desirable, on many accounts, that those who occupy elevated positions in the social scale should possess that species of information which would assist them in fulfilling their domestic duties. This kind of information, however, is not easily acquired in a desultory manner, particularly at the time of life when it is first wanted and required to be brought into play.

The editor is of opinion that the heads of families should not be contented with the knowledge that may be gained from uneducated persons, who necessarily commit innumerable errors in their reasoning; but that they should understand the rationale of the various processes put in practice by others, which alone can give them the power of distinguishing between what is judicious and what is faulty. To say nothing of the female portion of society, who are more particularly expected to regulate and direct domestic affairs, there are many situations in which some acquaintance with domestic matters is indispensable even to the lords of the creation. This is more especially the case with officers in the army and navy, and with those who emigrate to form colonies.

It is vain to expect many valuable improvements from persons who have only what is termed mere practice to depend upon: by frequently repeating the same operations, they acquire a certain degree of skill, but being without principles to guide them, their attempts at improvement too often prove abortive; and if some scientific acquirements be essential to the progress of the domestic as well as the other arts, to whom should we look for the possession of these advantages? The answer is obvious—to those possessed of affluence and leisure, who have alone the means of attaining it sufficiently. It would be useless to pursue this subject farther; and thus much has been said to account for some peculiarities in the present work, where the editor has adverted to this subject.

The editor ventures to hope, that to many this suggested union of science with practice will not prove irksome; on the contrary, he is satisfied that much rational amusement may be derived from the experiment. It may not be necessary for every one to brew or to bake, make wine, or light a fire; yet to go through each of these operations once, so as to comprehend the principles upon which success depends, may really be made an entertaining occupation.

In another point of view, it may be observed, that some persons, unacquainted with the intimate connexion that exists between the several branches of human knowledge, have wondered how chemistry could be useful to a cook, or the philosophy of heat to a housemaid; and are, consequently, inclined to ridicule what they look upon as the pedantry of science. But it ought to occasion no surprise that the knowledge of the properties of steam should be necessary to those who constantly use it, or that some acquaintance with the theory of ventilation

should direct the practice of those who have to change the air of our apartments. The wonder, indeed, is, or should be, that each should perform his duties efficiently, without some acquaintance with those laws of nature which have been included in the term Philosophy.

To illustrate still farther his general views, the editor will now advert briefly to the manner in which he has treated each of his subjects.

The subject of Building naturally claimed his first attention; but the views by which he was guided in introducing this branch of the work, as well as the nature of the information conveyed, are so fully described in the work itself, as to render it superfluous to enlarge upon it here. The subject of Warming is not so well understood, even by men of science; and though the limits of the work precluded the possibility of entering so fully into the subject as the editor could have wished, yet he trusts that his opinions, being the result of long experience, will be regarded as sound and trustworthy.

Ventilation is now beginning to be considered important; but it is evident that to practise this with effect, a knowledge of the theory is indispensable. Artificial illumination is more within the power of persons of little science, but valuable improvements, as already remarked, are seldom perfected by them alone. In this part, the Historical Account of Lamps, and the description of the most important Apparatus for Artificial Light, may claim some attention on the score of originality.

The subject of ordinary Furniture is better known; and, indeed, it may appear to some little necessary to have collected so much matter in this branch of the work; but the editor was of opinion that collecting in one work the various articles of household furniture would be useful to those who are beginning housekeeping, to whom the greatest part of the work is particularly addressed.

The subject of Food is one of the most important and interesting in Domestic Economy, and can never be treated satisfactorily without alluding to chemical and physiological science. The editor has endeavoured to steer a medium course between what might be considered as scarcely intelligible to the general reader and the mere form of receipts. He has endeavoured, indeed, to tempt the reader to an investigation of what has hitherto been much neglected by the public in general, and left almost solely in the hands of medical men. On the subject of Beverages, many erroneous opinions prevail, and health demands that it should be better understood. It may, perhaps, be supposed that he is an alarmist with respect to adulterations, and that he has followed the example of the author of "Death in the Pot;" but he has carefully avoided stating anything for which he had not sufficient authority; and he has, in many cases, suppressed what he believed to be true, lest it should appear to throw some doubt upon the rest.

The description of the materials for the cook, and the philosophy of

the culinary art, have been kept distinct from the mere practice of cookery, because many might be desirous of understanding the first without wishing to go into the details of the latter; and likewise because the editor was deficient in the practical knowledge which has been supplied by a lady, whose experience in this part of Domestic Economy enabled her to treat it with propriety. And here it may be proper to state exactly what portions of the work were executed by the late Mrs. Parkes. To her are due the whole of Book VI., "On the Duties of Household Servants;" Books XII., XIII., and XIV., "On English and French Cookery;" and Book XXVI., "On the Preservation of Health, with Hints on Domestic Medicine," the latter being principally supplied by her son, Mr. Parkes, a surgeon, and the article on "Bathing," by the editor. For all the rest of the work the present editor is alone responsible.

With regard to Dress, he has contented himself with describing the usual materials, with the arts of manufacturing them, and has added some information on the Toilet, which he trusts will be found conducive to health.

In his project for a Still-room, the editor has suggested a kind of apartment in which certain experiments might be carried on, compatible with modern science, and in which philosophical chemistry, applicable to domestic purposes, might be substituted for the practice of former times.

The account of Carriages is altogether new. Some directions respecting stables and horses are necessarily added. The Dairy, both as to its construction and the operations of making butter and cheese, next succeeds; and this is followed by the management of the various domestic animals. The last article, "On Health," will no doubt be found to convey valuable information in aid of professional assistance.

To treat so many subjects with the necessary care, and within a limited space, has demanded considerable research, great caution in balancing opinions, and much industry in forming the heterogeneous mass of materials of which the work is composed into one compact body. It would have been easy to have published miscellaneous scraps as information was gained, but this would not have answered the end proposed—that of explaining the elementary principles upon which each branch depends.

In conclusion, the editor begs leave to express a hope that his labour has not been misapplied, and that the mass of matter here brought together will be found deserving the attention of the public. He may add, that all the woodcuts have been executed from drawings made by himself, mostly from original objects.

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ENCYCLOPÆDIA

OF

DOMESTIC ECONOMY.

BOOK I.

ON THE DOMESTIC RESIDENCE.

CHAPTER I.

CHOICE OF A SITUATION.

One of the first objects which usually engage the attention of those who are just setting out in life, and on the eve of forming a domestic establishment, is the acquisition of a dwelling. In England, it is generally the desire of every one whose finances can afford it, to have a house of his own. In other countries, even wealthy families are often contented to occupy a part of a large mansion; but this practice is inconsistent with those views of domestic comfort which an Englishman looks forward to at his own fireside, where he may plan his arrangements of a permanent nature without molestation. This feeling is peculiarly characteristic of England,* and the anticipation of these domestic pleasures is, perhaps, one of the strongest inducements to those exertions of industry which are not surpassed in any other part of the world. The great improvements which have been made of late in the interior of our houses are, in a great measure, the result of this national taste.

1. *The primary consideration in the choice of a residence is generally the situation;* and the next is the suitableness of the building to the wants of the family that is to inhabit it. It is not always the good fortune of those who are desirous of possessing a house of their own to meet with one that will suit them in every respect, and more particularly when they have limited themselves to a particular locality. A house already built may stand in need of some repair—perhaps to be modernized, or to have additions made to it; and where considerable alterations are required, it may be a question, which is too seldom asked, whether it would not be better to build a new one; for it happens not unfrequently that, from one alteration giving rise to another, the expense of these at last exceeds the cost of a new house. To make a judicious choice of a residence, it is therefore necessary that the intended occupier should not only well consider his principal wants, but understand all the essential points to be attended to in supplying them. An improper choice is often very difficult to remedy, and may destroy much of the comfort that was anticipated. To supply the requisite information on this subject will therefore be our first endeavour.

2. *The situation of a domestic residence* may be conveniently reduced to three classes: that of a town, suburban, and a country house; each of which has its peculiar advantages.

3. *A residence in town* is superior to any other for social intercourse and varied enjoyment by means of public and private parties, theatres, concerts, balls, public libraries, museums, exhibitions of works of art, with numerous opportunities of acquiring general knowledge. In the choice of a town residence, one must be guided not only by peculiar views, but by the comparative healthiness of the street; its aspect, neighbourhood, and many other local circumstances, which are, in general, pretty well understood. Not only the width of the street, but its direction, is important; one running east and west must have one front of the houses looking to the north, and deprived of the sun almost the whole of the day, while the other is exposed to its full radiance.

4. *A suburban residence*, or one in the environs of a city or town, offers some advan-

* [This "peculiar characteristic of England," as it is styled by the author, belongs to civilization, and not to England exclusively. Not even there are the comforts of home desired or enjoyed with greater ardour than in the United States, where families far from being wealthy do nevertheless seek those domestic pleasures which appertain to a separate home, preferring even a small house or humble cottage, rather than to occupy a "part of a large mansion." The "other countries" of which the author speaks are not to be understood as including America, our citizens being generally characterized by their affectionate regard to "their own firesides."

This "national taste" has resulted in the adoption of all the improvements in the interior of our dwellings which British refinement has introduced, besides superadding many which are peculiarly American.]

tages that cannot be obtained by living in town. The situation is, in general, more healthy, the air not being so much contaminated by the thousands of chimneys that are perpetually throwing out smoke and deleterious gases. Ground not being so valuable as in town, many more conveniences can be acquired, such as a garden, and perhaps a field or two, attached to the house; and this additional space may be built upon, according to any proposed plan. Thus this kind of residence, while it possesses many of the advantages of the country, such as good air and plenty of room, may, at the same time, enable the occupier to enjoy occasionally the conveniences of a town life. The pleasure to be derived from a garden, and from the cheerful and enlivening effect of trees and vegetation in general, together with quiet and absence of smoke, and innumerable disagreeable objects constantly presented in cities, are circumstances worthy of consideration. It should be mentioned, however, that in the immediate vicinity of towns the atmosphere is still in some degree charged with noxious matters, particularly when the wind blows in certain directions; and therefore, in order to enjoy the full benefit of pure air, it is necessary to remove to a sufficient distance beyond their influence.

5. *Those who resolve to settle entirely in the country*, at a distance from large towns, must make up their minds to be deprived of many of those advantages of a town and suburban life which we have enumerated. The opportunities for social intercourse must, in general, be more limited, and even the proximity of neighbours may not be agreeable. The varied amusements which town affords can only be expected at long intervals. In return for these deprivations, perfectly pure air may be obtained; also retirement, and a species of independence, with a distinct class of enjoyments. But except those who try a country life have some resources within themselves productive of amusement and agreeable occupation, the want of society will often cause such a life to feel dull. Mere walking or riding to preserve or improve health is frequently irksome, and should therefore be connected with some object. The study of some of the numerous branches of natural history will present an inexhaustible field for agreeable observation. The operations of gardening are to some highly amusing; but the cultivation of plants will prove doubly interesting to enlarged and inquiring minds, if they add to it some acquaintance with vegetable physiology and the theory of agriculture. The resources afforded by reading are well known; but it is not so generally understood how much pleasure is derivable from the power of drawing and painting, nor how much the arts of design unveil to their votaries innumerable beauties in nature.

6. *Very large estates* are commonly subdivided into farms, or portions, which are let off at certain rents to cultivators, with a view of producing income to the proprietor. In this case, he may either have a residence or demesne on the estate, or he may live elsewhere.

7. *The management of a farm*, which includes agriculture and all the arts connected with it, forms a subject of vast extent and importance, and will be best studied in works devoted to that object, such as "Loudon's Encyclopedia of Agriculture."

8. *The choice of a situation for a demesne* on a large estate must depend upon numerous local circumstances; for though it might appear that the centre of the estate holds out most advantages, yet these may be more than counterbalanced by others, depending upon soil, aspect, roads, picturesque appearance of the country, neighbourhood, &c.

9. *With respect to climate*, there can be no doubt that, upon the whole, a temperate climate is best; but the degree of temperature best suited to particular individuals must depend upon their constitution, feelings, and habits. Between the northern and southern parts of Britain, there is a considerable difference in the climate. The south coast of Britain is allowed to enjoy milder winters than any other part, and is therefore much resorted to by invalids, or those whose constitutions demand a mild air. On the contrary, some prefer a residence in a mountainous district, where the bracing atmosphere invigorates the system. Before determining on a particular part of the country to settle in, it would be well to visit it at various seasons of the year; for nothing can be more different than a mountainous region, a plain, and even the seacoast, at different seasons.

10. *The healthiness of the situation* is the most important consideration of all in fixing on a spot to reside in. This depends upon the air, dryness or dampness, soil and exposure, the vicinity of various objects, character of the surface, &c. Regard must likewise be had to the constitution of the occupier. In ancient times, the necessity of defence caused the dwellings of the wealthy to be strongholds built upon the tops of hills, where they were necessarily exposed to cold winds; and when, in peaceable times, this necessity no longer existed, it became the fashion to fly to the opposite extreme, and to build houses in the lowest situations, as being the most sheltered. But this gave rise to still greater inconvenience, that of confined and unhealthy air; and many old mansions may be seen placed in the bottoms of valleys. It is to be observed that, contrary to the opinion often expressed, the richness of the vegetation by no means proves the salubrity of the air in which it grows; for it is known that plants flourish luxuriantly in an atmosphere that would be dangerous, or even fatal to human life.

11. *A gently elevated situation* is generally the most healthy. When the surface of the ground is hilly, there is seldom a perfect calm for a long-continued time during bright

sunshine; for one side of the hills being warmed by the sun more than the other, a corresponding inequality is occasioned in the warmth of the air, and this gives rise to currents or breezes; whereas, in a dead flat, this effect does not exist, and there the most steady climate may be expected. Gentle breezes are extremely agreeable in close, sultry weather; but this frequent change from warm to cold is apt to prove injurious to those who have weak lungs: such persons also find a hilly situation inconvenient, as they suffer much from the fatigue of walking up the slopes. Although a level plain exhibits none of the picturesque and beautiful prospects that are seen from rising ground, and may be hot and sultry while a hilly situation enjoys a cooling breeze, yet, on the other hand, it is easiest laid out in walks, and is preferable for gardens and the cultivation of plants.

12. *Exposure and Aspect.*—These terms are employed, the first to express the comparative liability to be affected by certain winds, the latter by the sun's rays. A situation exposed to violent or cold winds from any cause is not desirable; and, in some cases, long observation is necessary to ascertain accurately to what winds particular localities are most exposed. In most places there are prevailing winds that blow more in one direction than in any other; and more particularly in elevated situations. A house is more exposed on the side of the rising ground towards the point from which such winds blow than on the opposite side. When there are many hills together, a prevailing wind may be so deflected that a house may be more affected when not quite facing it; notwithstanding, in some cases, as in the vicinity of large cities, the side most exposed to the prevailing winds will be best, because least liable to be annoyed by the smoke.

13. *The aspect* has much influence on the warmth and general comfort of a dwelling. A southerly aspect has the advantage of the sun's rays during the greater part of the day; an aspect to the north never has full sunshine, and is therefore cold and cheerless. An aspect to the east has the sun only in the morning; one to the west, only in the evening. With respect to the views from the house, with an aspect due south—the objects opposite are all in shade in the middle of the day, and the contrary is the case with one to the north; but in the morning and evening, in both cases, they are partly in light and partly in shade. Grounds sloping to the south are sooner dried by the sun after rain, and are less covered with snow than when they slope to the north; the advantage of a southerly slope is particularly observable in gardens, which produce earlier crops of vegetables, fruit, and flowers, than a northern one.

14. *The seaside* has been much resorted to of late on account of its benefit to health, not merely for sea-bathing, but for the air alone; and it is rather remarkable that its peculiar salubrity should not have been noticed formerly, for it is not, perhaps, above fifty or sixty years that the benefit of sea air has been particularly noticed.

15. *A situation near a lake or broad river* has some of the properties of one near the sea; it is cooler in summer and warmer in winter than an inland situation, because the water, being less warm there than the land, gives out less heat to the air in summer, and the water having lost the least heat in winter, cools the air least. The temperature of the atmosphere, therefore, in the vicinity of large masses of water, is more uniform than that over land. Currents of air or wind are likewise more easily created when water is near; because the land, being most heated by the sun's rays, occasions an ascent of the air in the daytime: hence the sea and land breezes of warm climates. The banks of a river are often preferred for the beauty of the prospects and the convenience of fishing, but they are unhealthy if there is any marsh land near, which gives rise to the ague and fevers, from the noxious effluvia, called malaria, generated by the decomposition of plants that grow in the water. A wide sluggish river like the Thames is apt to have mists and fogs on its surface. Sea marsh is the most unhealthy of all. Peat moss is entirely different from marsh, and is not unhealthy.

16. *The nature of the soil* is an object of great consideration in choosing a spot to build on. When gardens and pleasure-grounds are required, it is very desirable that the soil should be fertile; but when a garden alone is wanted, and particularly if on a small scale, the absence of a rich soil may not be a serious objection, since the soil can be improved by art. But in all cases a dry soil is essential; for though by artificial means the wet may be prevented from penetrating the walls of the house, yet the air in a damp situation is always loaded with moisture, which is not only disagreeable, but unhealthy. An eminence is generally dry, or, at least, it is usually capable of being rendered so by draining, which can scarcely be effected in a valley or very low situation. But a spot may be rather elevated, and yet neither be dry nor healthy; for there may be hills of greater height in the vicinity, or it may be backed or surrounded with thick woods, that render it liable to springs of water and stagnant air impregnated with noxious exhalations from decayed leaves. A strong clayey soil is retentive of surface water, and difficult to drain; hence it is unpleasant to walk upon after rain, and is easily broke up by horses and cattle; it is also the worst for gardens, for which the best is a loamy soil. A gravelly soil on an eminence is dry, but on a flat it is apt to generate damp in the lower parts of a house, because the water finds its way from all parts of the gravel into the hol-

low made by the foundation. The richest soil on an estate is not always the most suitable for the mansion, though the most valuable for agriculture.

17. *The subsoil* is sometimes of more importance than the soil; for though the latter may be improved, the former scarcely ever can. A bad subsoil is extremely injurious to the thriving of trees, which constitute one of the greatest ornaments of a country.

18. *Trees* near a mansion are agreeable, forming a pleasing composition with the architecture, affording shady walks in summer, and sheltering the house from high winds; but if near the house, and too tall or too close together, they obstruct the light, prevent the free circulation of air, and render the ground damp; also the decaying of the leaves in autumn, and the rank vegetation under them, sometimes give rise to unwholesome exhalations.

19. *In general, fine prospects from the house* are desirable; but tastes differ in this respect, some preferring that the place of residence should be rather secluded, and that the prospects should be at a little distance, to be reached by a short walk. It is agreeable if the views from the house have a kind of intricacy by which successive distances may be marked, and prevent any positive limit from appearing, the boundary of the property being surrounded by a haha instead of a wall.

20. *A good supply of water* is essential to the comfort of every residence, and should be one of the first things inquired about in choosing a spot to build on: the supply should not only be abundant, but the water should be of the best quality. The water of a river or stream is, in general, the softest, though sometimes that of wells or springs is equally so. If there is no water apparent, it will be proper to try by boring whether a well can be sunk with advantage; but on no account should any building operations for a dwelling-house be commenced until the existence of good water at the place be ascertained, or the means of transporting it from a convenient distance. Artesian wells may sometimes be formed. When no other supply can be obtained in a spot where it is resolved to build, recourse may be had to the rainwater collected on the roof, and conveyed, after having been filtered, to well-constructed tanks. It has been calculated by Waistell that the average quantity of water which falls on a square yard of surface in Britain, in a year, is 126 gallons; consequently 100 square yards of roof will give 12,600 gallons: this will serve to show what roofing will be required. For farther information on the subject, we refer the reader to Book viii., chap. 1, "On Water."

21. *The best situation for a mansion* is, in general, on the south side of a gentle eminence, as the soil is most likely to be dry, or capable of being rendered so by draining. This situation is also most likely to be free from noxious exhalations and mists, and to enjoy the full advantage of the sun's rays. We may observe that the above hints for assisting in the choice of a situation will apply equally in the case of a house already built as to that of selecting a spot to build upon.

CHAPTER II.

CLASSES OF DOMESTIC BUILDINGS.

The subject of situation having been discussed, the attention will now be directed to the kind of domestic building required. In the following considerations we will suppose that a new house is to be erected, since it is evident that by this means alone all the varied wants of different individuals can be completely supplied.

22. *The kind of house* must evidently be determined by the rank and wealth of the person who is to occupy it, the extent and habits of the family, their tastes, and, indeed, all those circumstances in private life that are too well known to be enumerated.

Domestic residences in this country vary in size and style by an infinity of shades; but in ordinary estimation they are divisible into several classes: as the palace—the extensive town and country mansions of any of the royal family, or of noblemen—the town house or villa of the wealthy commoner—the residences of an almost infinite variety of the middle classes—the house of the tradesman and mechanic—the cottage of the labourer. No rule can be laid down by which these different classes of dwellings can be accurately separated and defined; yet there is, and ought to be, a general feeling of propriety as to the character which each should possess.

23. *The Legislature, by the "Building Act,"* has divided all buildings in London and Westminster, and places within the bills of mortality, into several rates or classes, for the purpose of subjecting them to various regulations, partly for strength, and partly for security and the prevention of fires, and in part to improve the ventilation. Many of the regulations will be mentioned when we treat of "Construction."*

* [In America, the individual taste of our citizens is not restricted or interfered with by any "Building Act," although municipal regulations in many of our cities require a conformity to certain rules in the material and strength of walls having reference to the common safety, and especially to guard against the occurrence of fires.]

CHAPTER III.

ON THE VARIOUS STYLES OF ARCHITECTURE EMPLOYED IN DOMESTIC EDIFICES IN GREAT BRITAIN.

INTRODUCTION.—Having resolved on building, there still may be some difficulty in fixing on the style of architecture. In some countries custom and fashion are so dominant that one style is universal; and then there is no embarrassment, except as to size, and the arrangement of particular details. So it was in England a few centuries back; but in the present day we can scarcely be said to have a prevailing, certainly not a national style. The styles of architecture of various countries have been imported, and forms long since obsolete have been revived. Thus we have the Grecian, the Græco-Roman, the Norman, the Gothic, the so-called Elizabethan, &c.; and of these several modifications. Those who have studied antiquities and architecture may have some predilection in favour of one of these styles, or their architect may; and then it may be easily decided which is to be adopted. But when this is not the case, it becomes a grave, and not always an easily solved question, "In what style shall the new house be built?" Architecture not being a subject very generally understood, some remarks upon it may be proper before we proceed; sufficient, at least, to direct attention to the chief distinctive points that characterize the several styles.

24. *Architecture, considered as a subject of taste*, demands, like many other subjects, a peculiar study of its principles. Taste is always the result of actual knowledge and experience added to sound judgment, and is not an intuitive faculty. Some, no doubt, have minds so organized, as to perceive more readily than others the relations of various ideas and feelings, and so far appear to have naturally more taste. But architecture requires a great variety of acquired knowledge to estimate it truly; even an acquaintance with its history is essential towards forming a good architectural critic. In painting and sculpture there is nature to refer to, of which all men are more or less judges, but in architecture, though its forms may at first have been in a great measure imitative, yet the original prototypes enter but in a small degree into the whole subject in the present state of the art, which is founded more upon utility and customs arising out of our wants. The genuine beauty and merit of architecture, indeed, consists mostly in fitness and adaptation to a purpose; and when this principle is lost sight of, as is too often the case, nothing can be more unmeaning, and even ridiculous, than descriptions of its imaginary or supposed character and excellences. No art requires more than architecture the curb of philosophic inquiry into its principles. If permitted to run wild under the influence of certain feelings produced by the imagination, it loses its true dignity, and degenerates into affectation.

25. *Notwithstanding, however, that the chief merit of architecture consists in its application to useful purposes*, yet it is universally admitted that it is capable, like other branches of fine art, of producing pleasurable ideas, and of displaying the progress and refinements of society. Indeed, so important is it in this point of view, that the very character of a nation depends, in no small degree, upon the style of its buildings, both public and private. But if the general diffusion of a taste for ornamental architecture be desirable, the introduction of a spurious taste is to be guarded against. Bad taste, like bad habits, is difficult to eradicate; and some persons become, after a time, wedded to their opinions or feelings, which they persevere in with an obstinacy often great in proportion to the degree in which they are erroneous. It is likewise unfortunate for this art, that its errors cannot be rectified so easily as some others. An absurd fashion in dress may be changed in a season, but a house erected in bad taste remains for many years a monument of the want of judgment in the architect, and, perhaps, in the possessor.

We have stated that, in order to understand the various styles of architecture, some acquaintance with its history is essential. In the following slight sketch we shall confine ourselves to domestic buildings.

SKETCH OF THE HISTORY OF STYLE IN DOMESTIC ARCHITECTURE.

26. Our knowledge is extremely limited respecting the private dwellings of the various nations of antiquity. We have, indeed, the descriptions of a few in classical writings, and there are some actual remains in Pompeii; but though from the latter we may derive much information as to the distribution of the apartments and their manner of decoration, yet they are in too ruined a state to exhibit completely the designs of the interior of the houses. Notwithstanding the taste exhibited in many parts of these antique domestic dwellings, yet they were very deficient in many circumstances which afford so much comfort in modern times, particularly in their want of glass windows, and the various modes of producing artificial warmth which renders our houses so agreeable in all weath-

ers. It does not appear that it was the custom among the ancients, until a late period, to effect in the exterior of their ordinary domestic dwellings any approach towards the magnificent style of their public edifices; and we may, perhaps, consider this as a proof of their judgment, since it preserved the great distinction of character, which ought to form one of the elements of architectural design. For the Temple was reserved the lofty and conspicuous portico, with its pediment filled with rich sculpture; and on the Forum and other national edifices were lavished those examples of superbly decorative architecture, whose fragments, having survived the wreck of ages, still excite our admiration. But the habitations of individuals were at first, in all probability, but sparingly so ornamented, and were chiefly remarkable for their interior arrangements. The same thing may be observed in those parts of the world where the style of domestic architecture is still influenced by the habits of the classical period. Wealth, and its attendant luxury, at length produced ostentation, and with it bad taste.*

27. *It is remarkable, that at an early period in the history of Greece*, architecture as well as sculpture had arrived at the highest degree of perfection; and the exquisite taste exhibited in what remains to us of their edifices excites our utmost admiration. But these remains consist chiefly of temples, which, though individually different, have a great similarity of character; and there is little to guide us in forming ideas of the style adopted in other buildings. The columns, with their entablatures, that always surrounded their temples, gave them their chief character; and these are distinguished into various kinds, which are now termed the "orders" of Grecian architecture. Three orders are properly Greek—the Doric, Ionic, and Corinthian, named from the several places where they were invented, or chiefly employed. We have perfect examples of them still remaining in antique buildings.

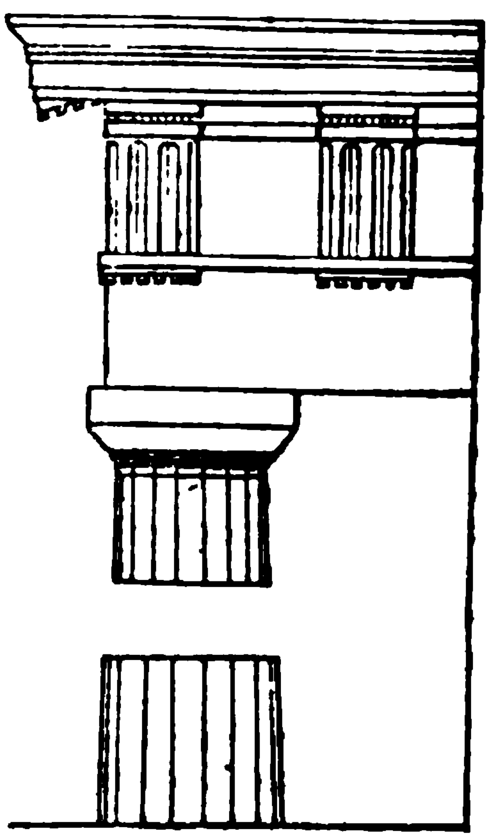


Fig. 1.

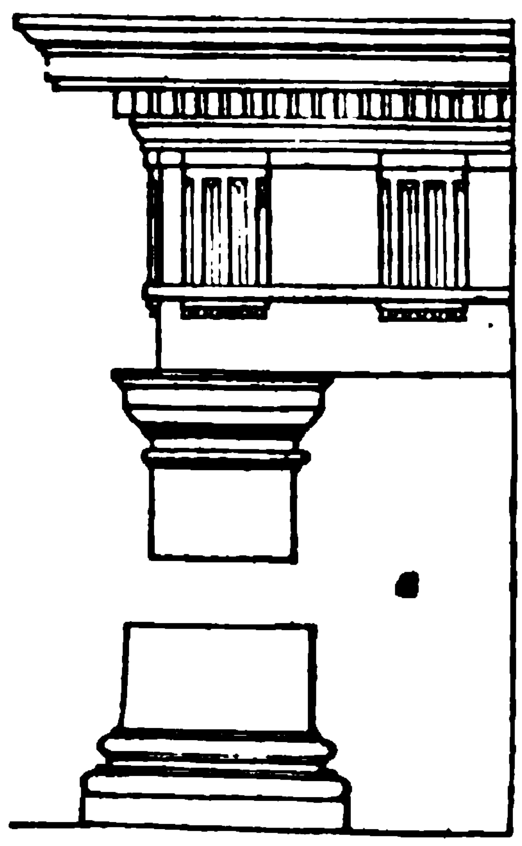


Fig. 2.

Fig. 1 is a part of the shaft of a *Greek Doric* column, with its entablature, such as it is seen in the Parthenon at Athens: it is distinguished by the peculiar flutings on the column, and the want of a base to the shaft. A good example may be seen in the portico of the Colisseum, Regent's Park, London.

Fig. 2 is an example of the Doric order as altered by the Romans, and such as had been used by the architects of the Cinque Cento period; it is still employed under the name of the *Roman Doric*.

Fig. 3 is an example of the *Greek Ionic*, from the "Antiquities of Ionia;" it is remarkable for the beauty of the large volutes in the capital.

Fig. 4 is *the Ionic order as executed by the Romans*, and as used by the moderns previous to their knowledge of the Greek Ionic. The capitals have smaller volutes.

Fig. 5 is the *Greek Corinthian* order, as it is seen in the Choragic monument at Athens.

Fig. 6 is the *Corinthian order as executed by the Romans*, and as it is generally adopted by the moderns. The capitals are decorated with the sculptured leaves of the acanthus.

Two other orders have been added, but these are not Greek.

Of the *Tuscan order* we have no antique example; and what has been given by modern writers and architects (*fig.* 7) is founded merely upon the description of Vitruvius. The other, called the *Composite* (*fig.* 8), is altogether a Roman invention, formed by placing the Ionic volutes on the leaves of the Corinthian capital.

* Vitruvius, an architect probably of the Augustan age, has described the interior arrangement of Roman dwellings, and to his work, and those of his commentators, we refer the reader who is desirous of inquiring into the subject. But information may be more easily obtained from "Gell's Pompeii," the "Library of Entertaining Knowledge," and other modern works.

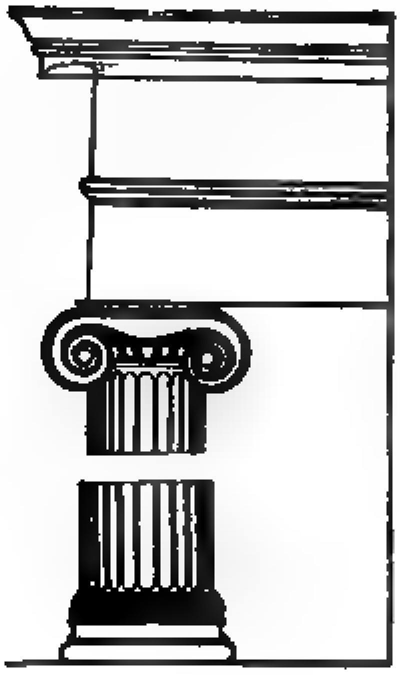


Fig. 3.

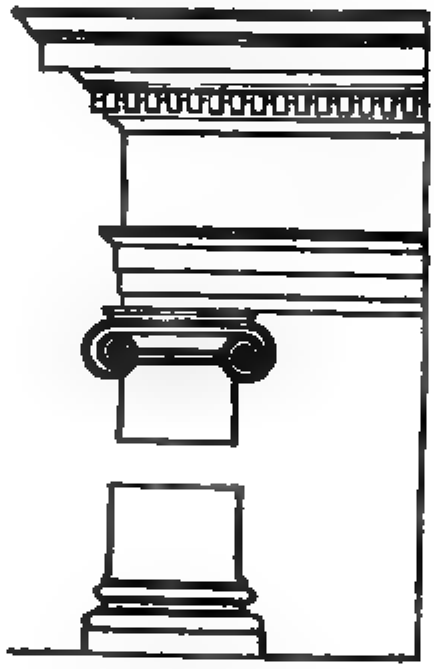


Fig. 4.

Fig. 5.

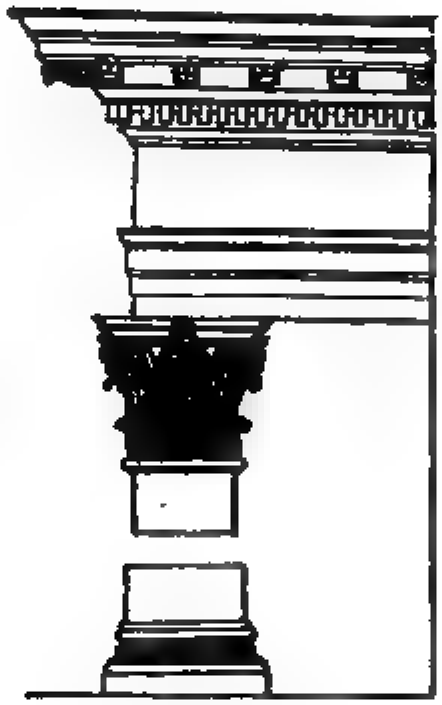


Fig. 6.

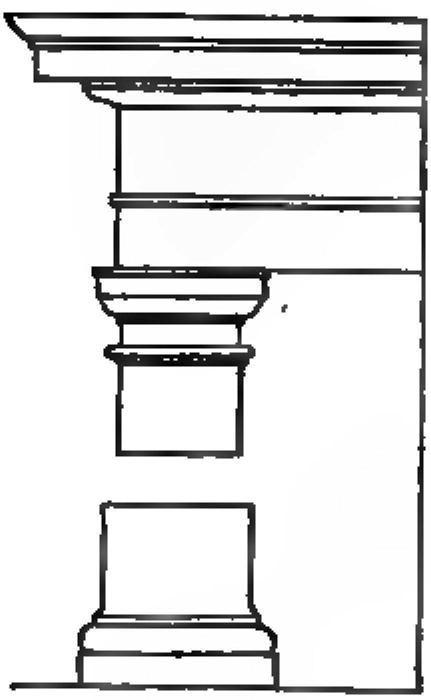


Fig. 7.

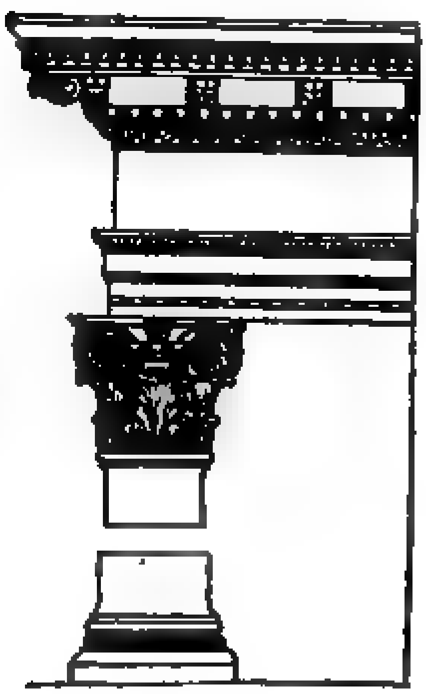


Fig. 8.

Fig. 9 is the front of a Greek temple, which has served as the prototype to so many modern porticoes

Fig. 9.

28. *What was the earliest style of architecture employed in Rome* is not known; but it appears that on their conquest of Greece the Romans borrowed from that country much of the style of architectural decoration; they did not, however, copy the Greek manner entirely, but altered it, probably to adapt it to their own taste, and for other reasons with which we are not well acquainted. Suffice it here to notice, that the style observed in the ruins of antique Roman buildings is very different from what is to be seen in the ancient remains of Greece, as may be observed in the examples we have given above.

29. *On the revival of the arts*, the Italian architects borrowed from the antiquities of Italy, and not from those of Greece; and as it was known that the Romans were indebted to Grecian art in a great measure, it was supposed that the styles of architecture in Greece and Italy were not materially different; the whole, therefore, passed under the name of Grecian architecture. The visit, however, that was paid to Greece by Messrs. Stuart and Revett, disclosed to us the actual style of the Greeks, and proved that it was very distinct from the Roman style. The accurate and beautiful publication of the "Antiquities of Athens," by Stuart, put architects in possession of the true Greek style; and after some contest as to its superiority, long-rooted prejudices being difficult to eradicate, it came into fashion here as well as the Roman. It does appear, however, that each of these varieties of style possesses a peculiar merit; hence they are both preserved, and we have now a Greek and a Roman architecture; but the difference is observable rather in the detail than in the general appearance, as may be observed in the above wood-cuts. One difference we may also notice. It is a remarkable fact that the ancient Greeks do not appear to have been acquainted with the use of the arch; at least no authenticated antique example proves that they were; nor does it seem clear by whom this very useful kind of construction was discovered. But it appears to have been practised by the Romans in the time of their kings, the great sewer of Rome, the C Maxima, stil

der Tarquinius Superbus. Roman architecture is ch terized by the frequent use of arches, vaults, and do in addition to their employment of columns and parts, which form a vast source of variety and inte *Fig.* 10 is an example of a mode of employing the in a composition by Bramante: the manner is Rom

30. *The few remains of ancient Roman villas in Br* prove that the antique style was introduced here; b was annihilated, and probably forgotten, during the sequent inundations of Saxons and Danes, of whos mestic buildings we possess scarcely any knowle The ecclesiastical architecture formerly termed Sa and now early Norman, distinguished, among o things, by its peculiar clumsy column, circular arch, zigzag ornaments (*fig.* 11) observable in many of our

Fig. 11.

oldest churches, may evidently be traced to a barbarous imitation of the latest Roman style. It appears also in some of our earliest castles; but probably was not employed in the inferior domestic dwellings of the Norman period, which, for a long time, were entirely of wood, and, consequently, have disappeared. Nor does this style appear to have sufficient attraction to be imitated in our modern houses, and therefore we need not dwell upon it.

31. *The slender column and pointed arch* (*fig.* 12) *are the distinguishing characteristics of what has long been termed Gothic architecture*; a designation which, whether strictly proper or not, we shall not attempt to set aside for any of those which have been invented to supersede it. The origin of the pointed arch is still involved in obscurity. It appeared all over Europe nearly about, or soon after, the period of the Norman conquest, as may be traced in the numerous ecclesiastical and other buildings both in England and on the Continent, and arrived, in a progressive manner, to a wonderful perfection. Though it possesses merit of a very high degree, yet its character is so very distinct from the Greek and Roman style, that it is difficult, and perhaps useless here, to institute a comparison between them; while, at the same time, we must observe that this would require numerous graphic illustrations, and entering into numerous details inconsistent with the plan of this work. Farther information must therefore be sought for in works devoted expressly to this subject: for actual examples, the reader has only to look at the cathedrals and churches in most of our principal towns. Gothic architecture, in its various stages, prevailed all over the island for several centuries, from the time of Henry I. to that of Henry VIII. Its admirable adaptation to ecclesiastical purposes is generally acknowledged, which may be seen in our ancient ecclesiastical buildings, and the remains of monastic edifices. The houses of private individuals during that period were chiefly of timber, and were ornamented occasionally with parts in the same taste.

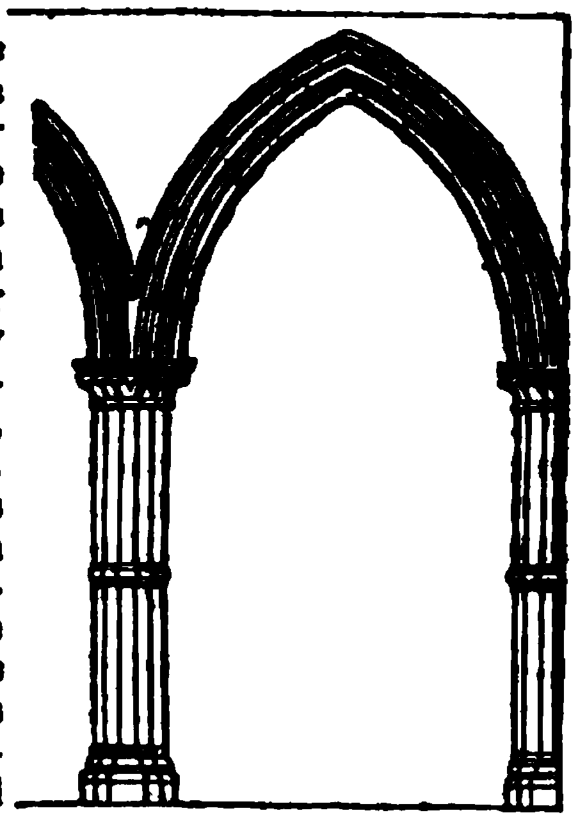


Fig. 12.

32. *In the reign of Henry VII. a considerable change took place* in the style of English Gothic architecture. The arches, which always before that time had been more or less high-pointed, as at *fig.* 12, were lowered, and formed by uniting portions of circles of different sizes, as *fig.* 13. The windows of private houses were generally made rectangular, though divided by mullions, each bay being sometimes filled up with a low-pointed arch. Extremely ornamental chimney-tops were also displayed, giving altogether a peculiar character. Independently of the ecclesiastical architecture in this style—such as King's College Chapel in Cambridge, St. George's Chapel at Windsor, Henry VII.'s Chapel in Westminster, &c.—there are still remaining many perfect examples of domestic architecture, chiefly manor houses, of the times of Henry VII. and Henry VIII., and some so late as that of Queen Elizabeth. It has received by modern architects the title of the *Tudor style*, from the royal families during whose reigns it was general. See *fig.* 21.

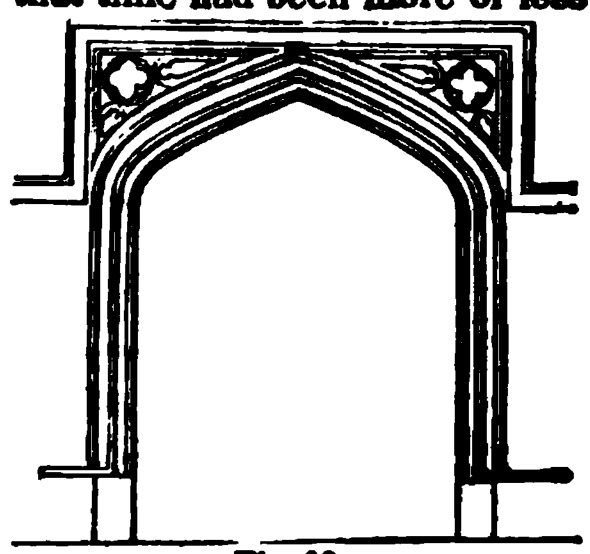


Fig. 13.

33. *In Italy*, where there were still remaining so many antique buildings while it was in the possession of the Goths and Lombards, the Roman architecture, which had fallen into a debased state on the decline of the empire, was imitated in a rude manner during the Middle Ages; and the buildings erected during that period, a few of which are still to be seen, belong to what is known as the Lombard style. Afterward appeared a mixture of this barbarous architecture with Gothic pointed arches. In the same building, and even in the same front, portions in both styles are seen in sad confusion mixed with conceits of a puerile kind; an example of which occurs in the church of San Antonio at Padua, begun by Nichola Pisano in 1231.

A reformation in architecture was begun early in the fifteenth century by Brunelleschi, a Florentine architect, and was followed up by Alberti, Bramante, Vignola, Serlio, and others; but their style of design was far from being free from the faults of the former period. Indeed, in this old Italian school were produced numerous absurdities, which, to the present day, have not wholly disappeared; and by the revivers of Roman architecture the beautiful character of the antique was never well understood. One of their great errors was the endeavour to reduce the parts of what are termed the orders of architecture to positive rules in their proportions; thus subjecting the art to trammels that have proved inconvenient, and which, indeed, tended in time to reduce architectural

design almost to a mechanical trade, contrary, as would appear from antique remains, to the practice of the ancients, although, in some degree, sanctioned by the writings of Vitruvius.

A taste for good sculpture long survived the decline of general architectural design in Italy, and hence were retained, in the architecture of that country, many ornaments and parts of beautiful form and execution, with much of the spirit of the antique. But these cannot preserve the buildings to which they are attached from the severe censure of the architectural critic; and the *Cinque Cento*, or Italian style of the fifteenth century, though possessed of many excellences, is not deserving of being perpetuated as a whole. But, notwithstanding this general censure, which applies more particularly to churches and other ecclesiastical buildings, it must be admitted that in the Cinque Cento style of architecture there are innumerable beauties as well as absurdities, and abundant proofs of genius in the architects of that period displayed in their fertility of invention. The modern architect will find in the buildings of Italy an inexhaustible field for study, and, perhaps, a cure for that monotony and insipidity now so prevalent among us, provided he has sufficient knowledge of fine art to select what is good, without copying the whole. In particular, many of the palaces of Rome, Florence, and other Italian cities have been generally admired by the best judges for their simplicity and grandeur of design in the exterior, as well as for the picturesque effects produced in the interiors. As specimens of fronts of these, we present the Farnese Palace in Rome, by San Gallo (*fig.* 14), and

Fig. 14.

the Pandolfini Palace at Florence (*fig.* 15). The Venetian territories have been enriched

Fig. 15.

by numerous palaces and villas designed by Palladio; one of which, the celebrated Villa Capra, is represented in *fig* 16. In the Italian villas may be seen beautiful examples of the truest taste in the combination of architecture with garden and picturesque scenery.

34. *Several circumstances conduced to produce an entire change in the architecture of this country* during the latter end of the Tudor period. Classical literature began to be more attended to, which, with the reform in religion, gave rise to new ideas, and the fine arts received a greater degree of attention. The style of architecture then prevailing in Italy was first imported partially into this kingdom in the latter part of the reign of Henry VIII., and appeared here occasionally as an incongruous mixture of the antique Roman style debased with many details, which, though not strictly Gothic, were evidently of Gothic origin. Many considerable mansions were executed in this manner during the

Fig. 16.

succeeding reigns, including that of Elizabeth, some of which yet remain tolerably perfect, and have acquired for the style itself, among English architects, the appellation of "Elizabethan," although it is evidently of foreign extraction. Good examples of it may be seen in the recent publications by Shaw, Nash, and others. *Fig.* 17 is a doorway in that style.

A kind of architecture so radically defective, notwithstanding a certain degree of merit which is allowed to it, could not long resist the effect of studying with diligence the remains of classical art in Italy; and from that country better ideas of antique Roman architecture were brought to this country by Inigo Jones, who imitated the manner of Palladio with success. With him commenced, in England, what is termed the Grecian (more properly Roman) style, but in which many of the errors of the *Cinque Cento* were long retained.

In the banqueting house of the Palace of Whitehall we see one of the best examples of the architecture of Inigo Jones. This architect was followed by Sir Christopher Wren and a host of others, as Hawksmoor, Vanburgh, Gibbs, &c., each of whom designed in the same general style, though with certain modifications of his own. At a late period improvements were introduced by Sir William Chambers (the architect of Somerset House), Wyatt, Soane, and those now living; but to describe these would be to write the detailed history of modern architecture. Suffice it to remark, that by far the greater number of large mansions erected in this kingdom for the last century and a half are in the style which we have just mentioned, of which *figs.* 18, 19, 20, are specimens. But this style of building,

Fig. 17.

Fig. 18.

though termed in general Grecian, was, in fact, rather Roman; the difference, however, cannot be easily understood except by those who have learned the elementary part of the science. The whole is therefore still commonly designated as Grecian architecture.

35. *Later architects, enlightened by a more careful study of antique remains*, had, in general, given up most of the absurdities of the Italian *Cinque Cento* school, preserving what

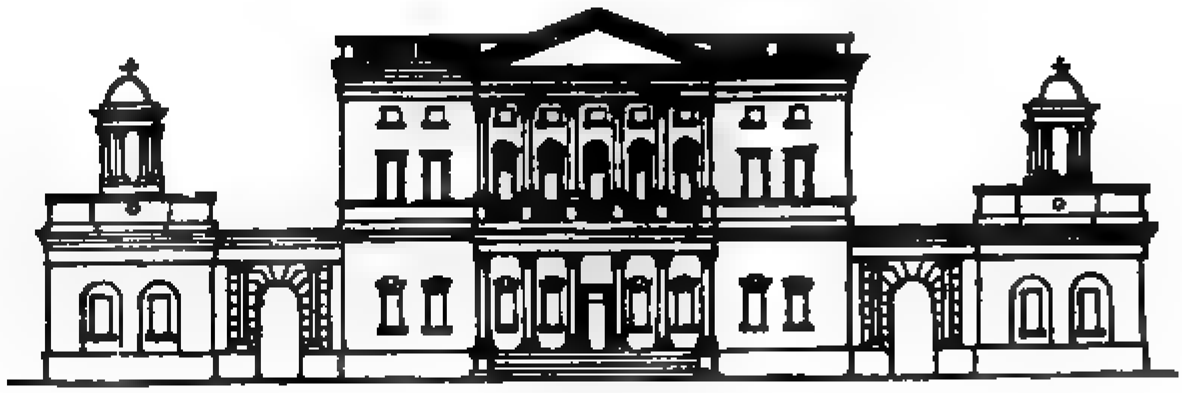


Fig. 19.

Fig. 20.

was most pure; and by their acquiring the knowledge of antique remains still to be seen in Greece, Sicily, and Asia Minor, architecture has been gradually improving.

OBSERVATIONS ON THE CHARACTERS AND PROPERTIES OF THE VARIOUS STYLES OF ARCHITECTURE, AS FAR AS THESE ARE APPLICABLE TO DOMESTIC PURPOSES.

36. It is generally allowed that the Greeks and Romans carried architecture to the highest degree of perfection; but it is unfortunate that, though we possess many remains of their public buildings, yet few traces of their domestic edifices exist. In reviving their style, therefore, after the long period known as the "dark ages," and applying it to domestic use, their public, and not their private buildings, necessarily became the prototypes; and certain parts and ornaments, which were, in all probability, limited by the ancients to religious and sacred structures, were employed by the moderns in the decoration of town mansions and villas; although there is great reason for supposing, as we have already observed, that the style and character of the private dwellings among the classical nations differed essentially from those of their public buildings.

37. *It must be admitted as a principle of sound taste* that every building should have a form and character suited to, and expressive of, its use and destination. But this rule does not appear by many of our modern architects to be very essential; for the same kind of portico that was employed by the ancients in their most magnificent temples, the same pediment and dome, are frequently made to form prominent features in a mansion, notwithstanding their unfitness for such a purpose. In some cases even the sculls, pateræ, and sacrificial instruments, have been sculptured upon the fronts of private houses, in defiance of all historical association; and it is unfortunate for the art that great absurdities have become so common, and the public is so familiarised with them, that it would require no little courage to point them out as errors. Some have no other idea of Grecian or Roman architecture than the modern mansions of England a century ago, as represented in *figs.* 18 and 19, or the still more recent ones of Portland Place and the Regent's Park; but we wish to state, that these were merely the attempts to adapt some portion of this style to modern English habits and customs—attempts often very unsuccessful, and sometimes grossly erroneous, or even puerile. Grecian architecture, in which we may, according to custom, include Roman, as having been in some degree borrowed from it, was eminently beautiful in the hands of the ancients; and instead of the monotony and sameness which are justly complained of in its modern dress, among them possessed considerable variety.

38. *What is termed modern Grecian architecture*, though not strictly Greek, is admirably suited to our present domestic habits, and is considered, by the greater number of well-educated architects and amateurs, as excelling every other style in the most important points; it is likewise more easily connected with the arts of painting and sculpture than any other. But it can be treated with great success only by the skilful and even learned artist, by whom the very perfection of antique architecture, and the paucity of standard examples, are felt as a source of difficulty that may cause many to shrink from it, while they fearlessly attempt the Elizabethan style, in which a certain coarseness of idea may pass. But the frequent failure of those who attempt to design in the classic manner is

no proof of its inferiority; and were this the place to point them out, it would not be difficult to mention several of the causes of frequent failure.

39. *Gothic architecture*, in its various stages, has for some time been a rival to Grecian, even for domestic purposes. Observing how admirably it is adapted to ecclesiastical edifices, it has been supposed that it must be equally well suited for mansions to dwell in. But this, according to the principle we have laid down, respecting the form and character agreeing with the destination, does not necessarily follow. Accordingly, there are a great many difficulties in adapting this style to ordinary dwelling-houses under our present circumstances. It is but of late that it has been so well studied that a marked difference has been perceived between the style employed formerly in buildings for ecclesiastical and for domestic purposes; indeed, there are few remains of the latter, except what belong to monastic, collegiate, or military structures; the private houses of our ancestors, even as low down as the reign of Queen Elizabeth, being chiefly wood and plaster; and the ancient timber houses, with their carved gables, high and often thatched roofs, casements, &c., though much admired as picturesque by some persons, have been imitated chiefly in small houses affectedly styled "cottages." It became, therefore, requisite, in designing a large modern house in the Gothic style, to look to more considerable examples. Some borrowed their ideas from ancient ecclesiastical architecture; and among the first attempts the parts were taken from churches, and even cathedrals; pinnacles, buttresses, ornamented battlements, pointed windows with stained glass, &c., were the sort of decorations that, it was imagined, would mark a Gothic mansion. It was soon found, however, that what was beautiful on a great scale, became only ridiculous when imitated in miniature; and when the architecture of our ancestors was studied with more care, it was likewise discovered that a profound knowledge of it was necessary, and even that it was essential that architects should be acquainted, not only with the difference between ecclesiastical and civil architecture, but with the styles of different periods; that, in short, they should be antiquaries as well as architects. It may not be necessary here to examine what association of ideas has originated the wish in some persons to inhabit a "castle" or an "abbey;" but certain it is that such imitations have seldom succeeded, and are not to be recommended in modern domestic dwellings. The situation best suited for a castle is seldom so for a domestic residence; nor is the low site, which will do well for an ordinary dwelling, characteristic of a place for defence; while most of those characters which render such remains of antiquity interesting are not attainable in a private house. The imitation of an abbey has not been more fortunate; and although the monastic character may appear more easy to preserve, still there are numerous circumstances that render the style of religious buildings, however excellent in the originals, unfit to be imitated in modern houses. The rich and florid style of ornament, so much admired in ancient Gothic edifices of the latest period, is generally too expensive for private individuals; and a plain Gothic style demands a certain magnitude to give it importance. Even when the rich kind of Gothic architecture is well understood, it is found extremely difficult, and almost impracticable, to preserve its true character in a modern house, except by a considerable sacrifice of simplicity in the interior distribution, and the introduction of much that adds nothing to convenience or use, but often materially interferes with them, besides causing much expenditure. If pointed arches are employed in the apertures, they create considerable embarrassment in the finishing of the interior; and even if the windows are rectangular, which they may be consistently with the style, yet these can scarcely admit of all the modern improvements in glass without destroying the ancient character which is wished to be kept up. If the house is to be Gothic, the furniture, or great part of it, should be in the same style, and generally must be made expressly for the place; hence another considerable source of useless expense, added to the giving up numerous modern improvements in so important a point of comfort. To this it may be added, that the designing all the details throughout of a Gothic mansion ought to be intrusted only to architects who have made this style their particular study, otherwise the incongruities produced may be numerous. But, notwithstanding what we have said, we are free to admit that, under the most favourable circumstances, Gothic architecture has a charm quite its own, but which it depends upon the architect to develop. Where expense is not an object of consideration, and where certain associations of ideas give rise to its preference, it is far from being impossible for the skilful artist to unite much domestic convenience with agreeable and tasteful forms. Our arguments militate against its general, rather than its occasional introduction; but we consider it as a "sine qua non," that if the style is to be Gothic, it should be so strictly, otherwise disgust and ridicule may be the result, which may be illustrated by the effect produced when ignorant persons attempt to imitate ancient costume.

40. *The Tudor Style.*—It has been often regretted that we have not among us a style of architecture that might be considered as peculiarly national. The high-pointed Gothic is common to Central Europe, and no country can claim it generally as its own. Although scarcely any remains exist of private domestic architecture of this style prior to the reign of Henry VIII., yet we have, as before mentioned, many manorial residences still

tolerably perfect, and other examples of civil architecture of the time of the royal race of the Tudors. Although some peculiarities may be perceived in the Gothic of each country, this is, perhaps, more strikingly the case with respect to what has been termed Tudor architecture, which is, upon the whole, much better suited for domestic buildings than the high-pointed and earlier Gothic; and for those whose associations of ideas incline them to wish for a style that may be considered as purely English, perhaps this has higher claims than any other, for it does not appear that it has been observed in other countries precisely the same as with us. But we must confess that our own taste does not lead us to recommend it, either as peculiarly beautiful, or as being well adapted to convenience and comfort; in short, as having all those qualities of the first importance which we should desire in a private residence; and we think that the loss of, or any great deficiency in these, is too great a sacrifice in favour of any associations, or the mere revival of a style not in itself of a superior kind. But as this is only individual opinion, we, of course, leave every one to adopt or reject it; and we must likewise state that our objections are limited to erecting an entirely new house in that style, for in the case of repairs of, or additions to, old mansions of Tudor times, the style should be strictly preserved; admitting, at the same time, that there are certain parts, as the oriel windows, which have great merit in every respect.

Fig. 21 represents part of a mansion in the Tudor style, from an excellent work on the subject, "Hunt's Tudor Architecture."

Fig. 21.

41. *Elizabethan Architecture.*—When we consider what was the origin of the style of architecture which has received this appellation, and examine several mansions that still exist in this country, which have had full justice done to them in late publications, it is difficult to imagine what could have given rise to opinions in its favour so strongly expressed of late. It is quite evident that it was, in great part, imported from Italy, and that, by the artists from thence, some of the monstrous absurdities of the Cinque Cento have been united to a few features of the early Tudor architecture. No doubt can exist of its partial Italian origin, even had we no historical evidence, when we compare the various grotesque carvings and other ornaments, and perceive their exact correspondence with what were common in Italy at that time, where, as we have stated, good architectural sculpture survived general design. The great beauty of some of the parts in the oldest Cinque Cento architecture is obvious, having been borrowed by the Italians from the antique, though in a great measure disguised by ridiculous conceits. With these are mingled an infinity of faults arising from imagination run wild, and a misconception of Greek and Roman feeling, though they were sanctioned by many celebrated artists of the Italian school. It is impossible to look over a few considerable mansions raised here in the time of Queen Elizabeth, and the two succeeding reigns, without recognising numerous absurdities in the details, notwithstanding we may feel the conviction that even these must have come from the hands of skilful designers, such as this country could not boast of possessing at that time among its natives; a truth, however, which perhaps can only be felt by those who are familiar with the details of antique and modern architecture.

Fig. 22, the front of Wollaton Hall, is a characteristic specimen of what is termed the Elizabethan style. This style, which begins to be considered as an "old English" manner,

Fig. 22.

has excited much interest of late, and has frequently been employed in the erection of country seats. In the present day, a strong feeling seems to exist of respect for what is merely ancient; and some who are enthusiastic add, likewise, a fancied perception of beauty in a style which to others exhibits much deformity. There is frequently no arguing where tastes differ materially, and where they depend chiefly upon feeling One advantage which has been derived from the present rage (shall we call it?) for the Gothic and Elizabethan styles is, that both have been studied, and are much better understood than formerly; and this, we must admit, is a certain step in the progress of architectural science. Besides, we are willing to grant that Elizabethan architecture has some legitimate claims to attention. It has a certain interest from associations; it has likewise some intrinsic merit, and possesses some good points. It can be more easily adapted to our present habits than Gothic; and we have some examples tolerably perfect in mansions of our ancestors, which may be sufficient to enable us to revive the style, should it be deserving of revival. Hence, those who are solicitous to avoid what may be termed antiquarian errors in design may possess in these models for imitation, parts of which are by no means devoid of merit. Although the grotesque ornaments with which the Elizabethan style is usually accompanied cannot be reckoned very fine, they are at least curious and amusing, and are calculated to display some taste, though not of a highly refined nature. Many of the forms are not a little uncouth; yet there is in the whole an air of richness and costliness, and the spectator is often so captivated with the general magnificence, as to be little disposed to criticise the individual parts. Considering its history and origin, and that it was the produce of a period when the arts were at a low ebb, it would be in vain to look for more. It harmonizes with the costume of the period when it took its rise.

42. *Doubtless, if any one acknowledged style is to be aimed at*, it will be a particular merit in the designer to exhibit a technical acquaintance with it, and to give its true character; but it may be a question whether it be necessary, at the present day, that our domestic architecture should be strictly either Grecian, Gothic, or Elizabethan. Should this question be resolved in the affirmative, the business of the architect will be brought within certain limits; he would then be, in a great measure, confined to the study of the models before him, and his powers of invention less called upon. In comparing the various styles, and in endeavouring to fix their comparative values from designs, it should be kept in mind as a well-known fact, that an artist of skill, possessed of the principles of composition, may make excellent designs in any given style; and therefore his success will be no proof of the merit of a style, which may appear better or worse according to the talent of the designer. Much will depend likewise upon the particular bias of the architect: one may have studied Gothic architecture much, but may have paid less attention to any other; he will, of course, be most likely to succeed in what he is best acquainted with. Those architects who first introduced Grecian architecture into this country, as Inigo Jones and Sir Christopher Wren, though men of great talent, have left us only miserable attempts at Gothic, which they had not studied sufficiently; and we find, on looking over the compositions of living artists, a great inequality in the merit of their designs, according to the particular bent of their studies. It is therefore easy to see how we may be misled by confining ourselves to particular examples, and

how necessary it is to take into our consideration an almost infinite variety of circumstances in criticising architecture.

43. *It must be obvious, from what we have already stated, that we are not inclined to give our full approbation to either the Gothic or Elizabethan styles of architecture for general adoption*, notwithstanding the argument of their nationality; nor do we see any good reason why a modern house should look as if it had been erected centuries ago, and why it should not rather exhibit the result of every recent discovery and improvement in the arts of building and domestic economy; nor why any of these should be sacrificed to feelings merely of association. Why should we look backward, instead of forward, in the history of society, and content ourselves with copying or reviving obsolete forms which have no particular merit, instead of exercising invention in producing something of greater excellence? In fine, why should architecture be so fettered, any more than other branches of the fine arts? In painting, the artist of the present day is not the most esteemed who can produce only a good imitation of a Poussin, a Claude, a Cuyp, or a Berghem. So far has the art of landscape advanced, that though the artist has availed himself of the works of these masters, he must likewise give proofs of his deep study of nature, the source of their excellence, and combine this with original thinking. Indeed, so far must he be from appearing a servile copyist of any one's manner, that he will be the less thought of should he strongly remind us of his predecessors. It is very true, that originality in architecture is far more difficult than in any other branch of the fine arts; because, as we have already observed, in the latter there is the wide range of nature to refer to. But would it not be possible for the architect to employ the works of his predecessors in the same way that landscape painters have done? selecting whatever is excellent, but also combining this with his own inventions, suggested, in a great measure, by the ever-varying habits of society, in so skilful a manner that his compositions may appear so far original as to render it impossible to discover whence they were derived.

44. *In the mean time, there is a style admirably suited for the villa*, both from its picturesque effect, and from the facility with which it might be adapted to domestic purposes. This style is known among architects under the designation of the *Irregular Italian*, and of which a tolerable idea may be formed from examples to be seen in the buildings introduced with the landscapes of the Italian school, as Claude, Poussin, &c. It was founded upon the villas of Italy of a few centuries back, which were composed from partial antique remains in the Roman character, with additions in a style somewhat different, and derived, in some cases, from the castellated manner which had become necessary for defence, together with forms suggested by climate, the whole being highly picturesque; a quality, however, derived more from accident than from any studied intention as to effect. In proof of its picturesque beauty, it is sufficient to observe, that it is always to this day chosen by landscape painters of the highest class in their principal compositions. We do not mean to say that perfect examples of this style can be pointed out fit for actual imitation, but enough has been done to suggest ideas to a skilful designer.

Regularity in the exterior, though essential in public buildings, does not appear to be equally desirable in a villa; on the contrary, the picturesque, as well as utility and convenience, demand more variety. Perfect regularity—that is, one half of the front corresponding to the other half, as in *figs*. 18 and 19—appeared to our architects of fifty or sixty years ago indispensable in every considerable mansion, and any deficiency in such symmetry was looked upon as an egregious error in a design; yet that this is not picturesque, is demonstrated by such formality being shunned by all painters. Nothing is more embarrassing to the architect than the necessity of preserving this perfect uniformity in the principal fronts, at the same time with the most useful and convenient distribution of the interior: many plans, that might otherwise have been made excellent, have been cramped and injured by endeavouring to attain the qualities of perfect regularity with that of great convenience. It would seem to have been forgotten, that the principal use of a house is to live in with comfort; and that, consequently, the interior should be planned first, the elevation, or exterior, arising out of it as circumstances admit. This practice, if followed, would introduce many improvements into our domestic distributions, would free the architect from his present trammels, and would lead naturally to that picturesque irregularity which is so beautiful in the hands of a tasteful designer. The formal symmetrical manner, so much esteemed some years ago in every architectural design, does not appear to have been considered so desirable by our ancestors; for in ancient works we often see a departure from it not easily accounted for, except by supposing some view to the picturesque. It must be observed, however, that when mere reduction of cost is considered, or how much space can be enclosed by a certain quantity of walling, that the perfectly symmetrical form has the advantage; indeed, it is easy to demonstrate that a cube will enclose more space than any other figure with plane surfaces, even more than one the plan of which is a rectangle; and hence it is, probably, that we have seen of late so many English houses erected in the form nearly of cubical boxes, or Chinese tea-chests, every idea of picturesque beauty being entirely out of the question.

The species of architectural design we are now advocating as peculiarly suited to the English villa embraces equally every class of building, from the humblest cottage to the largest mansion, and is consistent with the greatest economy or the highest luxury and expenditure. It admits of vast variety of forms, with every sort of decoration from painting and sculpture; and affords room for the exercise of endless invention, even bordering upon the capricious. Although, being founded upon Roman architecture, it does not admit of an evident mixture of any other positive style, yet it is not so exclusive but it may borrow from other styles various details, even of the Lombard style, if so modified that their origin is not recognisable. But in selecting parts not strictly Grecian or Roman, to give a wider range and more variety than if confined to the antique, we do not recommend introducing many of the gross productions of the old Italian school, which have, to a certain degree, vitiated modern architecture throughout Europe. On this subject it is unnecessary to enter more into detail: those who have made architecture their study will understand the points to which we allude; and to teach those absolutely unacquainted with the science, a work expressly intended for that purpose is necessary. Meanwhile, the above hints may afford some assistance, and therefore will not be misplaced.

[Every variety of architecture may be found to have been adopted in different parts of America, both for public and private edifices, and these are often complicated most barbarously, to suit conflicting tastes, even in the same building. The Grecian and the Gothic may be regarded, however, as the predominant styles of architecture in this country, especially for churches and other public buildings. That there is an increasing taste for excellence in this department would appear, from the preference given to architects who have cultivated the science in the best schools abroad, for recent structures in the United States. One specimen only is here inserted, by way of comparison with foreign edifices, viz., Trinity Church, now erecting in New-York.]

CHAPTER IV.

ARRANGEMENT AND DESCRIPTION OF THE VARIOUS APARTMENTS.

Much of the comfort of a house depends upon the judicious arrangement of the several apartments, and this is the first thing that usually occupies the study of the designer. The ground-plan of a house in every country must vary with its habits and customs, and what is excellent in one may be extremely unsuitable in another. This subject has been much studied by English architects, and various collections of plans have been published, which may assist in designing a new one. We may here observe, that it is not our intention, in this work, to give a collection of plans for domestic dwellings, since that would demand more space than would be consistent with our numerous subjects. When we consider the great variety of plans to be adapted to the various classes of society, and the wants and tastes of individuals, it must be obvious that this can be exhibited only in works devoted expressly to that object. The specimens of architecture given above in the woodcuts are not intended as examples to be followed, or as designs for imitation, but only to illustrate what has been said on the subject of style. The plan of the interior of a mansion to be built may be good, yet the interior may not be approved of; but in that case it is very possible to design another elevation to the same plan, or some judicious alterations may be made. It is too often the case, that, in order to produce an agreeable elevation, or exterior, the architect sacrifices the convenience of the

interior. Alterations of a plan may be easily made upon paper; and if every person could be taught to draw plans—a thing of very easy accomplishment—we might expect considerable architectural improvements, as far, at least, as convenience is concerned.

The following hints respecting the qualities or requisites of various apartments are intended to assist those who may make the attempt of designing plans of domestic buildings. It is by no means supposed that even a very extensive establishment must contain all the apartments here enumerated: a selection from them will, in most cases, be sufficient.

45. *Porch or Portico.*—Some contrivance for shelter should mark the entrance to a private dwelling; and this is usually affected by a porch or portico, the former consisting of a recess, and the latter of projecting columns supporting an entablature. The style of these must be regulated by that of the rest of the building and the taste of the architect; but the porticoes before the entrance, which have been often adopted in modern English mansions, as well as in those of other countries, consisting of lofty columns of the height of two stories, appear inconsistent with the obvious purposes of utility, and are too ostentatious to be sanctioned by good taste; it is also an objection to them, that, besides being uselessly expensive, they unavoidably darken the windows of the upper story. This kind of portico is evidently an injudicious attempt to apply the front of an antique temple to a domestic residence, without considering the different destinations and characters of the two edifices.

The original use of a portico of lofty columns among those ancient nations from whom it was borrowed, was to promenade beneath; and they were accordingly attached to and surrounded temples, into the interior of which the mass of the people were not admitted; or they consisted of colonnades in various places for walking in: but four or six columns placed in front of private dwellings cannot even be supposed to have the same object, and it is evidently raised as ornament only, though misapplied.

46. *Entrance Hall.*—If the mansion be large, a spacious entrance hall, or, as it is sometimes called, the *Vestibule*, has a good effect; but in a small house, the hall and staircase are usually thrown into one, which, besides occupying less room where space can ill be spared, has the advantage that both may be warmed together. The floor is frequently laid with stone or marble, and mosaic would be elegant.

47. *Staircases.*—The size of the principal staircase, and the part of the building where it is placed, affect considerably the convenience of the residence. Sometimes it is too large for the rooms; and, in other instances, its smallness gives an air of meanness. In large houses, the staircase is usually placed near the middle of the plan, and is lighted by a skylight; but in small houses it is on one side, that it may have the benefit of windows. Access to the staircase should be easy and obvious to all, and it should likewise afford free communication to all the rooms to which it leads. The back staircase, on the contrary, should be more concealed, being chiefly intended for the servants. The principal staircase should always, if possible, be of stone; and it were well if the other staircase were made of the same material, in case of fire, and to lessen the noise from feet.

48. *Breakfast-room.*—Except in large houses, there is seldom a separate breakfast room, the dining-room being generally used for this purpose. But if there be space, a breakfast-room, looking to the east, will be found agreeable; and it should, if possible, communicate by glass doors with the garden, conservatory, or lawn.

49. *Dining-room.*—This should be placed so that the way to it from the kitchen is easy, and yet so that it is not in the least annoyed by noise or odour from the latter. If possible, there should be an adjoining room for servants, and to collect dishes and dining apparatus in, that time may not be lost in bringing them in; and it will be useful to have there a steam table to keep dishes hot. A good deal of ingenuity is requisite in contriving a comfortable dining-room, in arranging the approaches to it, and connecting it with the drawing-room. Steam or hot water has the great advantage of warming it equally in every part; and the situation of the sideboard should be judiciously fixed.

A method first practised at the *Café Mechanique* in Paris, of raising the dishes up by machinery, and now frequently used in coffee-houses and taverns in London, might be adopted with advantage in some private houses. An instance is known in London, where the dinner is brought up from the kitchen upon an inclined plane.

50. *Drawing-room.*—This apartment is usually that which is fitted up with greater elegance than any other in the building. The windows are generally made to come down to the floor, with French sashes, and the walls are ornamented in a tasteful manner with painting or rich ornamental papering. The style of the whole should be lively and cheerful; and a well-designed chimney fireplace is most congenial with English habits and feelings. Few drawing-rooms are without some ornaments of sculpture or painting; and good taste is evinced in their selection: much of the trumpery toys often seen there would be better omitted. Two drawing-rooms opening into each other are found convenient either in town or country.

51. *Saloon.*—The name of *Salon*, on the Continent, is equivalent to our drawing-room: with us the saloon is rather a room of communication between others, or one to be used

occasionally for music, dancing, &c. It may be fitted up with ottomans round the walls, and may sometimes serve also as a picture gallery.

52. *Library.*—The size of this apartment must depend much upon the taste of the owner, and whether his collection of books is considerable. The style of the room and furniture should be rather plain; the walls stuccoed and painted in oil; the light good, but quiet: a skylight is best, to give more room for bookcases. If it can be conveniently warmed by steam or hot water, with good ventilation at the same time, it will, perhaps, be preferable to having an open fire, as it will be free from the trouble and dust of a chimney fireplace. Besides the books, it should be furnished with maps, globes, &c., and, perhaps, with microscopes and other philosophical instruments.

53. *Gentleman's Study, or Business-room.*—This may adjoin the library, being intended for greater privacy and quiet.

54. *Billiard-room.*—This in the country is found a useful resource for exercise in bad weather. The best billiard tables are made of cast iron, slate, or some substance not liable to warp.

55. *Hunting and Fishing Tackle* require a separate room, or convenient closets, according to the taste and amusements of the proprietor and his friends.

56. *Gallery.*—By this term is designated an apartment for a particular purpose, such as for music, for pictures, for sculpture, &c. It is generally of longer proportions than usual. If for pictures or sculpture, the light should be from above, either by skylight or windows placed very high up, and only on one side. Very few architectural ornaments should be introduced, as they tend to draw attention from the subjects for which the gallery is erected. It should be provided with long seats or ottomans, as well as chairs, and should be warmed by steam, hot water, or warm air. Pictures and sculptures are seen to more advantage in a gallery contrived for their reception than when disposed over the walls of a house, where many must be placed in unfavourable lights and situations. The gallery may, though attached to the house, be under a separate roof, which, indeed, will sometimes be found necessary on account of the light.

57. *Lady's Sitting-room.*—This should adjoin her bedroom or dressing-room. In France, the *boudoir* is often the most highly ornamented part of the house, which English habits and taste do not require.

58. *Bedchambers.*—It is of great importance to health that the apartments in which we pass so many hours should be lofty, and, if possible, spacious, as a change of air during the night is not easily effected. Nothing can be more injudicious than the too frequent practice of making bedchambers low, to suit what is thought to be the picturesque appearance of a domestic edifice, where persons often submit to the serious inconvenience of low rooms in the upper story, and even of a thatched roof, as if it were desirable to copy the imperfections of our ancestors. We will not contend against the supposed principle of taste in diminishing the height of each story as we ascend, but remind our readers that the air expelled during respiration, though it rises at first to the top of the apartment, yet, if it has no outlet, descends as it cools, and mixes with what we breathe, a circumstance which was not known formerly, when bedrooms were constructed scarcely loftier than seven or eight feet. By referring the reader to Book III., "On Ventilation," the manner in which we consume the air of an apartment will be understood, and the value of the above remarks comprehended. The apertures in the bedroom story should be so placed that a thorough draught can be obtained in the daytime, for the purpose of changing the air completely. Every bedroom, even the least, should have a chimney fireplace, however small. An eastern aspect is the most agreeable for a bedchamber, because it receives the first rays of the sun; an evening sun, on the contrary, heats it, and renders the air oppressive. Small closets, and beds in recesses, are extremely injurious to health, as they can seldom be well ventilated. The style of furnishing in bedrooms should be neat, but plain, and everything capable of collecting dust should be avoided as much as possible. See Book V., "On Furniture."

59. *Dressing-rooms and Baths* should be attached to the bedchambers as much as is consistent with the size and style of the house: the addition of the latter is more than a mere luxury.

60. *Nursery.*—For directions respecting this place, we refer the reader to that part near the end of the work, where the nursery is treated of expressly; observing, that wherever it is placed, attention should be paid to its security from fire, and the ready means of escape. There should likewise be an easy communication between it and the lady's bed or dressing room.

61. *Schoolroom.*—This is frequently a necessary apartment, particularly in the country, where the young people are educated at home. It should be fitted up with a library of the most useful books, maps, globes, and the various apparatus required in education; and here might be kept the little cabinet of natural history, philosophical apparatus, &c. It can scarcely be necessary to observe that the warming and ventilation of it should be perfect.

A small chemical Laboratory for experiments might be attached, or be easily accessible, which should be perfectly fire proof; and a little *workshop* will likewise be an addition that may afford both amusement and instruction.

62. *Museum.*—This is not a usual addition to a mansion, yet well deserves to be one. It need not be large to contain a very entertaining and instructive collection of such objects of natural history as must interest the occupants, or would be useful to the junior part of the family. The various objects placed in it should be arranged and displayed with the greatest possible neatness and taste, yet without gaudy ornaments; and there should be connected with it a place for unpacking and for keeping unarranged specimens, not to encumber the museum itself. The light should be good, and convenient cabinets and tables provided.

63. *Observatory.*—Those who are fond of astronomy may have a room at the top of the house, perhaps in a tower, which forms a picturesque part of a villa in the Italian style. In this may be kept a good telescope, and other instruments, which may be a source of frequent amusement: such a room, if not used for astronomical purposes, may be found agreeable and convenient for viewing the surrounding country, or for studying the clouds, &c.

64. *Conservatory.*—This is a building constructed for the growth and preservation of trees, shrubs, and plants, chiefly exotic, and is often attached to the mansion, and so placed that some of the principal apartments communicate immediately with it. It is a modern improvement, and it is an agreeable luxury to enter from a library or breakfast-room suddenly into the midst of odoriferous plants. A conservatory should, if possible, be so large as to afford walks in it, which ought to be paved, the plants growing either in the earth, or in pots sunk to a level with the surface. It is warmed by flues, or by steam or hot water; the sides and roof should be of glass, and the latter should be strong enough to resist hail. When the roof is opaque, the plants do not flourish. The style of architecture should be extremely light, without large piers, which obstruct the sun's rays. Some splendid conservatories have been executed of late, for which see "Loudon's Encyclopedia of Gardening."

65. *Domestic Offices.*—In arranging the plan of a house, the situation and distribution of the offices demand much consideration; yet they are frequently the most defective part of the mansion. The present fashion of placing many of them in a sunk story, though economical with regard to expense and space, is often injurious to health and cleanliness. In towns this is, in a great measure, unavoidable, according to present custom, but in the country a superior arrangement is generally practicable. To the architect must be left the distribution of the several places according to the plan of the rest of the house and the particular locality; and we can do little more at present than enumerate the various apartments that are included under this head, with such few remarks as may appear the most essential; observing, that a proper arrangement of the several offices cannot be made, nor their fittings-up completed in the best manner, except by those who will take the trouble of making themselves intimately acquainted with the business to be done there.

66. *The various offices* usually connected immediately with the house itself are, the kitchen, scullery, pantry; the several larders, as the wet, dry, fish, game, and vegetable larders; salting and smoking-rooms. There are also the servants' hall, the steward's room, butler's room, plate closet, men's washing and dressing room, knife and shoe cleaning place. Then the housekeeper's room, storeroom, stillroom, china closet, maid-servants' sitting-room; lastly, the various cellars for wine and beer, iceroom, coal cellars. Forming a group by themselves, and detached from the house, may be the brewhouse, bakehouse, washhouse, and laundry. The dairy, dairy scullery, and cow-house may be situated in another part. Also, composing a separate group, may be the coachhouse, harness and saddle room, stables, dog-kennels, stable-yard, and lodging-houses for the servants employed in them. In the approach to a villa or country mansion the offices should, as much as possible, be kept out of sight.

The principal requisites of a good kitchen are stated in a separate part of this work, where the processes of cookery are described. A good chimney fireplace should never be omitted; for whatever improvements are made in the apparatus for cooking, yet it is not prudent to dispense with the open fire, which may or may not be used continually. Good ventilation to the kitchen should be provided for in building; for if this be neglected, it will, perhaps, be impossible to effect it afterward. If the ventilation be sufficient, it will not only keep the kitchen cool, but prevent the smell of the cooking operations from spreading over the house. The place for coal and other fuel, to supply the kitchen and offices adjoining, should be very near; and it will be convenient, and save much labour, if the coals can be passed from it into the kitchen by an opening in the wall. If the kitchen is detached, it may be lighted by a skylight, which will give the best light and allow most space on the walls.

The scullery should adjoin the kitchen, and be fitted up with a boiler, plate racks, shelves, plate drainers, cistern and sinks, a chopping block, and other conveniences well known. Where steam is much employed, this is generally the place where the steam boiler, with its necessary apparatus, is placed, from which pipes conduct the steam to the kitchen and the various parts of the house. It should be paved with flag-stones rubbed, and some recommend giving them one coat of oil to prevent grease from marking.

The qualities of a good larder are described under "Preservation of Food," Book X.

The other offices necessary to be connected with the house depend so much upon the whole establishment, that no rules can be laid down which can be generally applied. The requisites for a brewhouse are mentioned in Book VIII., "On Brewing;" and those of the washhouse and laundry in Book XX. The same may be observed of the dairy, cowhouse, and stables, which are treated of under their several heads. Some information respecting a good distribution of offices may be obtained from published plans, but better from inspection of such as receive a character of convenience from intelligent servants, who are often able to appreciate their merits, and who should therefore be consulted respecting them.

GROUNDS IMMEDIATELY ROUND THE MANSION.

Although our object in the present work is to confine our chief attention to the domestic edifice itself, without treating in detail on the manner of laying out the grounds, which is the proper business of the landscape gardener, and is seldom attempted by the architect, yet a few remarks upon that part which is in the immediate vicinity of the mansion would appear necessary.

In England, instead of having the cultivated land come up almost to the door of the dwelling, as is frequently the case in other countries, a certain space round the house is kept as pleasure ground, lawn, or park, and ornamented with trees, shrubs, and flowers; and this space is usually enclosed by a sunk fence instead of a wall, not to shut out the view of the country beyond.

67. *The approach to the mansion* in the old style was often directly in front, sometimes by a straight avenue. At present it is thought to be more agreeable and picturesque to avoid such formality, and to have the first view of the house on an angle so as to see two of its sides; the road being made winding, that it may present greater variety than when perfectly straight.

But admitting numerous defects in the ancient artificial and formal style of gardening, and the more just appreciation at present of the beauties of nature, it has been objected by the late Mr. Hope, that the modern custom of "launching from the threshold of the symmetric mansion, in the most abrupt manner, into a scene wholly composed of the most unsymmetric and desultory forms of mere nature, totally out of character with those of the mansion, is a deviation from propriety and good taste." In this respect, modern reform (which swept away the avenue, the terrace with its steps, balustrades, statues, vases, and other embellishments of old times, together with the more objectionable cut yews, trellises, and other unnaturally formal objects, and substituted mere wild, though picturesque, nature) has been carried to an extreme. The change, however, we must observe, gave rise to what is so deservedly admired under the title of the *English Garden*; but as this can be executed with success only on a scale of considerable magnitude, it is better, perhaps, when the space is more limited, to imitate something of the old style still to be seen in some parts of the Continent, as in France and Italy, where the regular forms of architectural and sculptural embellishments are mixed with natural objects in the immediate vicinity of the dwelling, to preserve a gradation from the regular forms of art to those of rural scenery more remote. The style of architecture to which we have alluded above, denominated the irregular Italian, admits of this variety much better than any other, and that consistently with utility, affording, by its terraces, colonnades and arcades, dry and sheltered walks, together with greater facility in preserving that neatness and cleanness near the house which is so desirable; while the beautiful ornaments of statues, garden buildings, and seats of various kinds, with parterres of flowers, fountains, bridges, and other decorations, can be introduced with propriety, although they might seem incongruous and misplaced in ordinary pleasure-grounds, which represent merely a selected portion of natural scenery.

But on this subject it is not desirable that we should dictate; and we throw out this hint rather to awaken attention to ideas perhaps too much neglected, notwithstanding they have been alluded to by persons of great taste and talents; and the existing desire for neatness and finish round our dwellings has become so general in England, that probably it is, upon the whole, best to leave this to the gradual improvement which is going on.

It should not be supposed, from what we have said, that we recommend any of the absurdities of the Dutch taste of former times, nor that we overlook the merit of numerous improvements of the present day: we only propose that a mixture of the artificial with the natural should be introduced, such as is sanctioned by the works of the greatest masters in landscape painting, who, having studied profoundly the principles of picturesque beauty, are, undoubtedly, the best acquainted with it. And at the same time that we express our opinion on the "capabilities" of the style we have advocated (to use the expression of an eminent landscape gardener), we must not conceal that it cannot be treated successfully except by artists of the highest class; and that attempts by those not well versed in the true principles of art are in great danger of being puerile, and even disgusting. It has been justly remarked that our mansions or villas are seldom well

connected with the surrounding grounds, owing to the architect and landscape gardener being distinct persons, or not acting in concert. There can be no doubt but that many of the fine compositions to be seen in Italian villas have been produced by the great artists of former times, when it was more the custom to unite the three professions of architect, sculptor, and painter.

As we recede from the mansion, the appearance of art may diminish, till at last it is no longer desirable, and we may trust to those characters which nature alone presents in perfection.

Water somewhere in the grounds is an agreeable feature; where it does not exist naturally, it may be sometimes introduced artificially, but so as if it seemed to belong to the place. Stagnant water, however, should by all means be avoided, since it is productive of noxious exhalations.

As we do not propose to treat here of modern landscape gardening as a science, we can only refer those of our readers who wish to acquire some knowledge of it to study the writings of Shenstone, Gilpin, Uvedale Price, Knight, Repton, Meason, the late Thomas Hope, most of whose principles have been collected together by Loudon.

68. *The entrance to the grounds* from the public road is usually marked by a large gate and lodge for the porter, which is sometimes an ornamented building. Perhaps it is good taste not to aim at ornamenting it much.

69. *The situation of the flower and kitchen gardens* must be regulated by the soil, aspect, and other circumstances depending upon the locality. It is convenient that the latter should be near to the stable court, and not far from the kitchen. For the management of the gardens, we refer the reader to "Loudon's Encyclopædia of Gardening."

CHAPTER V.

DUTIES OF THE ARCHITECT.

Since it is not always possible to meet with a house newly built with all the requisite conveniences, and in the desired situation, the only resource may be to build a new one, which can be exactly suited to the wants of the proprietor, and which may be constructed with all the modern improvements.

70. *Having resolved on building, the first step to be taken* is to engage an architect or surveyor, terms which are nearly synonymous, the chief difference being, that the former title is supposed to mark a higher grade in the profession. Having put the architect in possession of all the necessary information to enable him to design the intended mansion, such as the extent of the family and establishment, the limits of expense, &c., the first thing proper to be done is to make such rough drawings as shall convey a general idea of the plan and distribution of the apartments, together with the appearance of the exterior, accompanied by an approximation to the cost. This being approved of, it will then be necessary to prepare plans more detailed, and to make out an accurate estimate, the labour of which being very considerable, it is not advisable to go through it in the first instance, until the proprietor and architect thoroughly understand each other as to the convenience and style to be aimed at. This first step is too often omitted; and at once highly-finished drawings are made, the effect of which is to bias the judgment and inexperienced eye, or to give rise to unnecessary expense before the design is actually determined upon. There should, however, ultimately be plans of each story, carefully drawn, with elevations of the principal fronts; and it would be desirable if some kind of model could be got up at a small expense, for this would be much better understood by many persons than drawings alone. It must be evident how useful it is to bestow much care in considering the plans upon paper, as these can be easily altered, whereas alterations during the execution of a building are not only difficult and expensive, but often render the original estimate useless, and, indeed, lead to setting it aside. It ought to be known that it is quite possible to make an estimate for a new house that shall be very near the actual cost, but that this cannot be done where many alterations and repairs are introduced. In the former case, the estimate is produced by the same process on paper as is employed in measuring the building when finished; but, in the latter case, the estimate cannot be much more than conjecture. It should be a rule, therefore, to alter as little as possible after a building is once begun.

Together with plans and estimates, there is made out what is termed a *specification*, or *particular*, which is an accurate technical description of the manner in which the several works are to be executed.

71. *There are various ways in which building may be carried on; the best, and what may be termed the legitimate, mode*, is for the architect to select and engage all the master tradesmen, who should work entirely under his direction and superintendence, they being furnished with accurate *working drawings*, and copies of the specifications, which describe the kind of materials to be used, and all the necessary details respecting the work; and it is the business of the architect to see that these are most strictly adhered to

When the whole is completed to the satisfaction of the architect, and partly while it is going on, the several works are measured and valued by two persons. One is the architect himself, or some one appointed by him, and who acts for the interest of the proprietor; the other is employed by the tradesman to take care of his interest. These persons belong to a class of minor surveyors, who, being solely employed in measuring, valuing, and estimating, have more experience than any others in these operations, which are extremely laborious. The measurements being made out, are cast up into what are termed *quantities*; to each of which is attached the price usually agreed upon, and allowed by the general consent of the surveyors and tradesmen of the day, and which are founded upon the prime cost of the materials, and the time generally employed by the workmen, according to the observations and experience of the master tradesmen, together with a certain usual per centage for profit. These prices are severely criticised in case of any difficulty by the two surveyors, who have opposite interests to attend to, and they are at last adjusted as nearly as possible to what they ought to be.

The prices allowed for all the different kind of work in building are published every year or two in what are entitled "Builders' Price Books;" and although these are not sanctioned by the profession, nor considered as authority, being the work of experienced individuals only, yet they are very near the truth, and may serve to give a general idea of what is allowed by surveyors. Should any part of the work not be well done, or the materials employed be of an inferior kind, the employer's surveyor will not allow the price demanded. In short, the measurement and prices made out by the two surveyors employed in this business constitute the bill to be delivered to the employer, and it is signed by both the surveyors. Nothing can be fairer than this mode of doing business; anything like collusion is almost impossible, and we may safely say is never practised. In certain cases, indeed (but this is generally where the bill has been made out by one surveyor only), when the employer considers himself to have been overcharged, the bill is put into the hands of another surveyor to be examined, and deductions are made in prices, but more rarely in the quantities, from the great difficulties of their examination. If these deductions, marked in red ink, are not submitted to by the tradesman, a lawsuit may be the consequence; but as lawyers are unable to enter into such an affair as the examination of charges of which they have little experience, the case is generally at last referred to arbitration, two experienced surveyors being appointed arbitrators. This disagreeable conclusion may almost always be avoided by care and precision in the original estimates, by firmness on the part of the architect during the execution of the work, and by the proprietor not giving occasion to alterations. The architect receives so much per cent. upon the amount of the bills (generally five, or less, if the work is very considerable). Some persons imagine that this mode of remuneration offers a temptation to run the employer to greater expense than is necessary; but whatever may be the case in works on a very large scale, this can scarcely happen in ordinary business. If the most conscientious architect use every means in his power to make his estimates correct, and employ all his precautions during the carrying on of the work, it will almost always happen that the cost will somewhat exceed the estimate from unforeseen circumstances; on which account it is prudent to add something to the estimate for contingencies and extras: and should these turn out to be considerable, the architect will suffer in the estimation of his employer, while the trifling increase in his commission will by no means be an equivalent for his loss of reputation. It is therefore so much his interest to keep within his estimate; and such is the general desire of architects to do so, that the motives sometimes apprehended are scarcely possible.

The honourable architect, however, has a double duty to perform: he is not to consider himself as acting for the interest of his employer only, but he is likewise to do justice to the tradesmen under him, by allowing them reasonable and customary prices, provided the work is properly executed. The tradesman thus has the least possible temptation to slight his work, and the employer has the satisfaction of having the best chance that his house will be well built, and of paying no more for it than its just value.

72. *A deviation from this mode is sometimes practised.* Some master tradesmen being content with less profit than others, an agreement for *prices only* is made in the first instance, instead of having them to be arranged by the two surveyors above mentioned. This may reduce the bills somewhat; but there is some risk that the work will be executed in an inferior manner, yet so that the architect will not have it in his power altogether to prevent it.

A third mode is to have the work performed by contract.* Here the plans and estimates are made as before, and either each tradesman contracts for his portion, or some individual, called a *builder*, undertakes to execute the whole for a sum, he employing the several tradesmen, and perhaps doing part of the work himself. In this case, the architect or designer may or may not superintend the work; but if he should do so, he has

* [This is the course most generally adopted in America, contracts being entered into by "*builders*," who estimate the amount for which they will erect the house and complete it, according to a plan and specifications previously agreed upon. In this case, an architect may or may not be employed to superintend the materials and workmanship; though, in most cases, the builder, if a responsible and capable man, is himself employed as the superintendent, for which he receives a compensation per diem, or sometimes by a given sum for the job.]

much less the power of checking its bad performance than if the tradesmen had been employed by himself; and if the builder has engaged to do the whole at a low estimate, there is a great chance but both the materials and workmanship will be of an inferior description, particularly when there is no surveyor to superintend the execution. Many persons have the erroneous idea that by employing a builder only, they will save the architect's commission, and have the work executed as well and at less expense. This view, however, is fallacious. The mere builder, without any check, has it in his power to put in materials of an inferior kind, and to execute the work in a worse manner than he would be permitted to do by a respectable architect; and the employer, instead of saving five per cent., may actually pay 10 or 20 per cent. more than he ought, without the possibility of a remedy, and have the mortification that his house, after all, may be ill built. It is likewise to be observed, that it seldom happens the mere builder is much of an architect; he has usually been a tradesman, generally a carpenter or a bricklayer, and he is probably but imperfectly acquainted with the other branches of the building business, and deficient in that general knowledge which the well-educated architect ought to possess. Much evil to architecture has arisen from too little care having been bestowed on making estimates before work is begun, through which the actual expense has much exceeded them; and some blame may be attached to those who, not to alarm their employers, give in the lowest calculation, omitting to state any addition for expenses, which, though unforeseen, always occur. Numerous instances which have happened, of the cost of buildings executed under architects exceeding their estimates, have led to the employment of builders, who, together with upholsterers, have been too often intrusted with the duties of the architect. The remedy is, that young architects should apply themselves more than they usually do to the details in the practice of their art, and that they use every means practicable to keep within the limits of carefully made estimates. This is not the place for pointing out what should be the education and acquirements of an architect: it is sufficient at present to state that he should not only possess in an eminent degree the arts of design, but that he should be intimately acquainted with the execution of all the details of work in every part of the building business; and, therefore, that no profession can be cited where greater industry and application, together with good natural talents, are required, than in that of architecture.

There are some gentlemen who have an ambition to become their own architects; but such persons are never aware, until it is too late, of the difficulties they will have to encounter, nor of the vast variety of knowledge necessary, and which, for several reasons, can be acquired only in a professional way. They generally pay dearly for their amusement, and very seldom gain any credit by it.

73. *In the metropolis and its environs*, besides the architect or surveyor under whose direction a house is built, every new building is subject to the examination of a district surveyor, whose duty it is to take care that the conditions of the "Building Act" have been complied with.

74. *Twenty-four hours' notice must be given to the district surveyor* before any building or wall on a new or old foundation is erected within the limits of this act. The notice must be given by the first master tradesman who is to begin the work; and he is liable to a penalty of £20 should he neglect to give such notice, besides having all work condemned to be demolished that should be built contrary to the act. The surveyor receives a fee for his trouble, as arranged by the act, in proportion to the rate of the building. Anything built or altered contrary to the Building Act is to be condemned as a nuisance, and removed; and it is also the business of the district surveyors to examine all houses and walls in a state of decay, and to condemn them if their condition is considered ruinous and dangerous.

75. *The Building Act having passed* for the improvement of building, for security and health, and the prevention of fires, it is the interest of the public to see that it is not infringed. The district surveyors are accordingly very strict; and it is proper that every one who thinks of building or altering buildings should be aware of the principal regulations, and see that the district surveyor is properly informed of his intention to build. Neglect of this has sometimes led to serious inconveniences.

76. *Taking a house on lease, or purchasing it.* Every person about to take a house on lease, or to purchase it, should, previous to his doing so, have it well examined by an experienced surveyor, as to its actual condition, and the repairs that may be necessary. This is a matter that can only be properly understood by professional persons, for whatever may be known of the subject by others, it is scarcely possible that they can be aware of all the circumstances to be attended to; and the neglect of sufficient examination may subject the tenant at the end of the lease to make good delapidations, which being only in an incipient state when he took possession, required a practised eye to detect them. Badly-constructed drains or roofs, commencement of dry rot, settlements in walls, decaying or bad sashes, the strength and stiffness of floors, and many other circumstances are only well understood by professional persons.

CHAPTER VI.

HINTS ON THE PRACTICE OF BUILDING.

77. *General Observations.*—It is not our object to introduce into this work a regular treatise on building. What we propose is, to give those general ideas with respect to the construction of domestic residences which it may be useful for the employer to be acquainted with. When we are about to build, we cannot, as has been already observed, with propriety dispense with the assistance of an architect or surveyor; for the numerous details of actual work or execution in a building are too complicated, and require too much experience, for any one to direct, except those who have made building their profession. But it may, in many cases, be convenient to have such a general acquaintance with the subject as may give an insight into the principles of construction, and of the processes of the various trades employed, as well as in the modes of charging and checking expense, which not unfrequently far exceeds the intention, and even ability to pay, of those who venture on building.

SECT. I.—CONSTRUCTING THE CARCASS OR SKELETON OF A HOUSE.

The operations of the builder are divided into two parts, the formation of what is technically called the *carcass*, or skeleton of the house, and the *finishing*. The carcass comprehends the foundation, walls, beams, and joists of the floors and roof, covering of the latter, and woodwork of the partitions. What remains to complete the interior constitutes the finishing. We shall commence by a description of some of the principal materials, as bricks, stone, and mortar.

SUBSECT. 1.—*Bricks.*

78. *Bricks are the materials most generally employed* for the walls of private dwellings in this country; and when they are well made, and properly burned, no substance is superior in durability, as may be perceived in the remains of ancient Roman buildings, where the bricks are now as perfect as when they were laid, a circumstance owing to the skill and care which were used in their manufacture; but modern bricks are often so carelessly made, that they crumble to pieces in a very short time. Much judgment is, therefore, required in the selection and purchase of this material, which is best procured by visiting the several brick-fields before buying any. Where good brick earth exists upon an estate, some may venture to make their own bricks; but, to succeed, it will be necessary to engage persons who are experienced in digging and tempering the clay, and burning the bricks.

All clays, even the purest, consist of two kinds of earth, alumina and silica. When kneaded with water, clay forms a paste that is plastic, or capable of being moulded into any form. This may be dried in the air, or burned in the fire. In the former case, it acquires a certain degree of hardness; but if this dried clay be again ground up with water, it recovers its former plastic state. Sun-dried bricks, though not durable, were formerly used in many places, as Babylon, Egypt, &c., and are still employed in the East, but never in this country. If dried clay be subjected to a red heat, its hardness is much increased; and when broken into fragments, these are no longer capable of being softened by water, and uniting into a paste. Bricks well burned by fire form one of the most durable of building materials.

Pure clays may be made into extremely hard bricks; but, in the ordinary practice of brick-making, there are several circumstances taken into consideration. When the clay is of a very tough or adhesive kind, or "fat," as it is called, owing to the abundance of argillaceous matter, much labour is required in kneading and tempering it, and the bricks made from it are apt to shrink too much, and crack in the drying and burning. A mixture of sand prevents this; but if there be too much sand, the clay will not be sufficiently ductile, and the bricks will be too brittle.

In many parts of the country natural clay is found, consisting of the just proportions of clay and sand; and where there is a slight deficiency of either, this may often be supplied by artificial means. It is very rarely, however, that natural clays are found consisting only of alumina and silica. They usually contain also more or less of carbonate or sulphate of lime, magnesia, oxyde of iron, &c.; and these ingredients, though small in quantity, modify the nature of the bricks. The iron, if neither lime nor magnesia are present, gives to the bricks a red colour; but if lime be likewise an ingredient in the clay, the iron causes the colour to be some shade of a cream or yellowish brown. The Roman bricks, many specimens of which exist in this country, and which are of an admirable kind, are of a deep red, as were likewise all the bricks made here about a century ago; but as this colour is not thought so agreeable as that of yellowish or whitish stone, great pains have been taken of late to obtain bricks of as light a colour as possible—one circumstance, among others, which has led to their deterioration, though it has improved their appearance. Instead of using the strongest and toughest

clays, such clays are now preferred as have a considerable quantity of calcareous matter, and called *marle*, or technically *malm* earths. From this bricks are made of a light yellowish colour; and when natural clays of this kind cannot be had, it has become a practice to grind a quantity of chalk with the clay to produce the mixture necessary for light-coloured bricks.

79. *The common process of brick-making* is as follows: Brick earth, consisting of a clayey loam, of just proportions in the ingredients, is usually dug in September, and exposed in heaps of a few feet in height to the action of the frost of winter, which pulverizes and mellows it. The small stones are then separated, by grinding it in water, and passing it through a grating. The clay thus reduced to mud is now mixed with chalk ground with water to the consistence of cream, if any calcareous ingredient is required. After remaining until it has acquired sufficient consistency, it is finally tempered by working it in a pug-mill, when it is ready to be moulded. Formerly, before the pug-mill was invented, the clay was thrown into a shallow pit, in which it was trodden by the feet of men or oxen. When the clay has been properly tempered, it is taken to the moulder's bench, and separated into small pieces. The mould is a box of a size fixed by act of parliament, but with the bottom loose. It is placed on the bench sprinkled over with sand, to prevent the clay from sticking to it; a lump of the prepared clay is dashed in, and the top scraped off with a flat stick. The newly-moulded bricks are carried on a wheelbarrow to a place where, arranged on each other diagonally, with spaces between, they are dried in the air sufficiently to bear removal, and are then fit to be burned. Should the weather be fine, a few days will be sufficient for the drying. The burning is performed either in a kiln for the purpose, or in clamps, which are large square piles of them skilfully built up, with small coal cinders, called *breeze*, between the layers, and openings sufficient to allow of the admission of air necessary for combustion. Kilns are generally used in the country for burning bricks, which is a more perfect mode; but for all the ordinary ones used in London, clamps are employed.

80. *Bricks burned in clamps*, and even in kilns, are not all of the same quality. Those in the middle, and the most perfectly burned, are called *stocks*, while those on the outside are more imperfect, and are denominated *place bricks*, and sometimes *samel* or sandel bricks: the latter are never employed in good work, or where durability is an object. *Common stocks* are both red and gray; they are used for ordinary walls. The burning of a clamp generally occupies twenty or thirty days, and requires great experience. If the bricks are too much burned, particularly where there is much lime present in the clay, they are apt to vitrify, and run together; and, if not sufficiently burned, they will have no durability. Bricks vitrified or too much burned are termed *burrs*; and though they cannot be used in walls, are useful in some situations. Bricks made with great care of a natural marly earth, or of an artificial mixture to resemble it, are extremely white and uniform, and are called *marle* or *malm stocks*. These are employed in facing the fronts of the best houses in London. A sort, called *cutters*, are made so soft as to bear being cut or rubbed into any form, as for the arches of windows. Some soft bricks are red, and are called *red rubbers*.

Paving bricks are made smooth, and a little thinner than common bricks.

Dutch clinkers are a small kind of bricks, imported from Holland. They are superior in hardness to any other, and were formerly much used, being highly esteemed for paving stables, where they were laid on edge; but now that some of equal quality are made at Cheshunt in Hertfordshire, and other places, the Dutch are no longer brought over.

An extremely white brick, used in the fronts of several churches near the metropolis, and some of the best houses, is made at Ipswich. Highgate Church presents a specimen of them.

Fire bricks, for furnaces and fireplaces, are of a different composition from ordinary bricks, as it is necessary that they should be infusible in high degrees of heat. In their manufacture pure clays are necessary, without iron or lime. The white clay dug at Stourbridge is the best for the purpose; and instead of sand, the clay is mixed with pounded old glass pots, crucibles, or fine bricks, which are not liable to vitrify. They are sometimes called *Welsh lumps*.

A soft and thin red brick, capable of resisting the fire, is likewise made at Hedgerley, near Windsor, and hence called *Windsor bricks*: they are used sometimes for lining portable furnaces and similar purposes, because they can be cut to any form, which the Welsh lumps cannot; but they are not so durable in strong heat as the latter, which are the only ones fit for lining grates.

Hiort's bricks may be mentioned as being valuable, on account of their forms for building circular flues for chimneys, which are more easily cleaned than square ones; but they are too expensive for common use. Another kind for the same purpose, but cheaper, has been invented by Chadley.

81. *Tiles* are made of clay, finer, tougher, and better prepared than that of bricks, and they are burned in a kiln. They are of different kinds, according to the use to which they are applied. They are for roofs, *plain* and *pan* tiles, also *hip* and *ridge tiles*. *Foot tiles* are used for paving; sometimes tiles are glazed, to render them more durable.

82. *The manufacture of bricks is placed under the control of the Excise*; and all bricks made in England for sale must be 8¼ inches long, 2½ inches thick, and 4 wide. Makers of bricks and tiles must give notice of their intention to begin the manufacture, under a penalty of £100.

The mode in which the duty on bricks is levied is complained of as a great check to their improvement. The present duty on common bricks is 5*s*. 10*d*. per thousand. To render the tax easy of collection, the brickmaker is restricted to the above-mentioned size. If he deviates in the least from these dimensions, or forms upon them any moulding, he renders himself liable to such an increase of duty as amounts to a prohibition of the article. Were it not for this, an infinity of forms of bricks might be contrived, suited to various purposes; and when we consider the durability of the material, and the facility with which it may be moulded into any required form, it is much to be regretted that means are not found for preserving the revenue without depriving the public of the advantages which might be derived from the inventions of architects.

It is remarkable that during many ages of the architectural history of this country, from the period of the Roman occupation to about the time of Queen Elizabeth, the use of bricks was unknown; and it is likewise remarkable that formerly they were made of much better quality than at present. Even so late as a century ago, the art of moulding a fine brick into various forms to suit the purposes of architecture was carried to a high degree of perfection, as may be seen in the beautiful red brickwork in the chimney shafts of many manor-houses, and in many other old houses, one of which remains in St. Martin's Lane, London. Excellent brickwork may likewise be seen in the conservatory in Kensington Gardens, and in many parts of the kingdom.

The general use of stucco on the fronts of houses, though it has much improved their appearance, has contributed in many cases, where they have been built upon speculation for sale, to deteriorate the soundness of the brickwork, by enabling builders to conceal their bad bricks through covering the exterior with a coat of cement.

SUBSECT. 2.—*Stone.*

83. *The selection of stone for building* requires considerable skill. Even the kinds usually mentioned as the most durable, as granite, porphyry, and basalt, are not always fit to be employed. Before using any kind of stone, the durability of which is not known, it is proper to observe what effect exposure to the weather for some years, and the frost of winter, have had upon it. No chemical analysis alone can give the required information on this point.

Granite, when of the best kind, is extremely durable, though difficult to work to a good face. It is, nevertheless, much employed in public works, and in some places, as Aberdeen, where it is very plentiful, all the private houses are constructed with it. Much of the granite used in London is brought from Cornwall and Devon, but the most durable granite comes from Aberdeenshire. This is of two kinds, gray and red, the latter being the hardest. Both these take a very fine polish, and splendid examples of polished granite are produced in Aberdeen, of which specimens are occasionally brought to London, both of columns and vases, which approach closely to Egyptian granite. *Porphyry* and *basalt* are too hard to be used for ordinary purposes. Other stones used among us for building are hard limestones, and such stones as are generally known by the name of freestone. The name of *freestone* is applied to such stones as can be cut readily, and as well in one direction as another, not being fissile or splitting into thin layers like slate.

When limestones admit of a polish, they are called marbles. All our fine white marbles are imported, for we have none in Britain of equal quality with foreign, except what is quarried in too small blocks, or is situated inconveniently for transportation. Though most of the veined and coloured marbles to be seen in use are also foreign, we have abundance of coloured marbles in Devonshire and Derbyshire, some of which are of considerable beauty; but they are not extensively employed. Gray compact limestone is durable, but cannot easily be worked into a smooth face, and therefore is not calculated to make an elegant front. Magnesian limestone is an exception; it is of a light yellow colour, extremely durable, and much employed in Yorkshire, and those parts of England where the quarries are situated, and is now used in the new Houses of Parliament.

The most usual stones for the fronts of houses in England are the freestones. *Oolite* is a calcareous freestone, composed of small rounded grains resembling fish roe, whence the name. It is abundant in many of the counties of England.

84. *Bath stone* is an oolitic limestone, so soft that, when fresh from the quarry, it can be cut by a toothed saw like wood, yet it hardens considerably in the air. All the city of Bath is constructed with it, and it is likewise now brought in considerable quantities to London, being less expensive than Portland stone, from the facility with which it is cut and carved; but it is not durable.

85. *Portland stone* is another variety of oolite, which has been used in the most important public buildings in London, and formerly for the paving of many of the private edi-

fices, till the use of stucco in a great measure superseded it. It is now employed chiefly in sills, coping, stone staircases, landings, and other subordinate parts of a building for which Bath stone is too soft.

86. *Sandstones* are freestones composed of grains of sand cemented together naturally: they are infinitely various in hardness, durability, and colour, some being excellent for the fronts of houses, while other kinds are so soft as to be totally unfit, or require being protected by stucco. Though sandstones are the best that consist chiefly of silicious particles, yet when the cement that unites the grains of sand is of calcareous or argillaceous matter, the durability is extremely variable, and only experience can determine whether they should be employed: it is the cementing matter that suffers disintegration by various causes, as the rain and frost; and when this is destroyed, the stone of course falls to pieces. The commencement of this destruction may be frequently observed by lichens growing on the stones, the decayed cement affording a proper soil for these minute plants.

Some kinds of stone lie in the quarry in vast masses, scarcely, if at all, in beds, and consequently they can be raised in very large blocks: of this nature are most granites, porphyries, serpentines, and many marbles, particularly statuary. Extraordinary instances of large blocks of these stones may be seen in the columns and obelisks of the ancients, as also in the walls of ancient cities; and very large blocks of granite are brought from Devon, Cornwall, and Aberdeenshire. Portland also furnishes large blocks of oolite. Sandstones are always in layers more or less thick; some layers furnishing good sandstone of considerable scantling, while others are only fit for flags and paving. This is owing to the manner in which the sand forming the stone has been originally deposited, and many sandstones are farther deteriorated by their containing fossil shells and other organic bodies. When these are numerous, the stone is seldom fit for facings.

Much valuable information respecting the building stones of this country may be obtained by consulting the Report made to the Commissioners of Woods and Forests on the occasion of selecting the best stone for the new Houses of Parliament.

87. *Of marbles* we have few that are the produce of this country; all our best marbles are imported from the Continent. Our white statuary marble comes from Carrara, in Italy. It is beautiful and fine grained, and is used not only for statues, busts, &c., but for the best chimney-pieces. We have no white marbles in Britain that can be procured in blocks so large, nor so fit for the sculptor. Of veined and coloured marbles we have many in Britain very good, but they are not much in use, few of them being of such richness as the Continental marbles. An interesting marble is found in Derbyshire, filled with fragments of the fossils called Encrinites, which is occasionally employed for chimney-pieces; and there is a great variety of coloured marbles in Devonshire, which deserve to be more employed. Black marble, as well as several others, are brought from Ireland. The Petworth and Purbeck marbles were formerly much used in Gothic churches, but they are now little known.

We may here observe, that English builders are in the habit of calling almost all stones that take a polish by the name of marbles; but the term should be confined to *calcareous stones only;* leaving serpentines, porphyries, &c., to be designated by the names proper to the species. Thus the serpentine of Anglesea is called, improperly, Mona marble: it is a beautiful stone, and was in considerable request some years ago; but the quarries are not worked at present.

Subject 3.—*Mortar and Cement.*

88. *Where walls have been constructed with very large and heavy blocks of stone*, as was the case with some in ancient Greece and Italy, the remains of which, called Cyclopian, are seen to this day, no cement was necessary, the weight of the masses being sufficient to keep them from being displaced; but with bricks or stones of the ordinary size, some cement is required to make a firm wall. In countries where bitumen is plentiful, this substance has been employed, as was the case in the buildings of ancient Babylon, existing remains of which have been described by recent travellers. But cements derived from calcareous substances are by far the most general, and are the only ones used in this country for the ordinary purposes of architecture.

Our common mortar is composed of lime made into a paste with water and sand, which, when completely dried, becomes of a stony hardness; and, the strength of walls depending much upon the excellence of this material, it is proper that the principles upon which its good quality depends should be understood.

89. *Lime*, or calcareous earth, familiar by sight to every one, is never found pure in nature, but is always combined with some other substance. Before it can be employed for mortar, it is necessary to detach it from its combinations; and all of what is so employed is obtained by exposing certain limestones to a strong heat, or burning them, as it is termed, in a kiln. Limestones consist of lime combined with carbonic acid, the properties of which as a gas will be particularly detailed in our section on Fermentation. In the limestone it is, however, in a solid state, combined with lime; and the stone is what chemists term *carbonate of lime.* When a red heat is applied to limestones, the

carbonic acid separates from the calcareous earth in a gaseous state, and flies off, leaving the lime pure, which is then called *quicklime*. This quicklime differs essentially from powdered limestone, and from chalk, which is also a carbonate of lime, in being caustic and soluble in water, which the carbonate is not. The newly-burned caustic lime is next to be slacked by pouring water upon it; the lumps immediately crack, fall to pieces, and soon become a fine white powder, at the same time giving out much heat, which occasions abundance of steam. But the greater part of the water is absorbed, enters into combination with the quicklime, and passes into a solid state; for instead of a moist paste being the result, as might be expected, the lime remains quite dry in the state of white powder. The union of the water with the lime forms a *hydrate* of lime, and is termed by builders *slacked lime*.

90. *Limestones are easily distinguished from other rocks*, by pouring upon them a little diluted acid of any kind, such as the nitric or muriatic: if an effervescence ensues, or the rapid formation of minute bubbles, the substance is limestone, the bubbles consisting of the carbonic acid gas which has been liberated from its combination, on account of the lime having a stronger attraction for the new acid than for the carbonic acid. A few other minerals besides limestone will afford the same appearance of effervescence; but as these are not in sufficient quantity to form large rocks, this test may be considered as practically sufficient to ascertain limestones.

Although all limestones consist essentially of lime and carbonic acid, and though lime may be obtained from them all by chemical means, yet, practically, all are not equally fit for burning into lime: for instance, white or statuary marble is a very pure carbonate of lime; but, when heated in a kiln, it is sometimes liable to fall into a coarse powder before the carbonic acid gas can be driven off, which prevents quicklime being obtained from it. Nor is it necessary that the limestones should always be of the purest kind for this purpose; for many limestones that contain a smaller quantity of other substances make better lime for mortar than the purest carbonate of lime. Limestones, indeed, may be divided into two kinds, as far as relates to their affording lime for mortar. Those which consist of pure, or very nearly pure, carbonate of lime; and those which, besides lime and carbonic acid, contain likewise a portion of clay, iron, magnesia, and sometimes a minute quantity of other matters. The lime procured from the first is capable of making a mortar that dries hard in the air, and which, when well made and become thoroughly hard, will not afterward soften in water; but if water be kept in contact with it before it has dried, it will never set or become hard: hence it is totally unfit for hydraulic purposes, or building under water. On the contrary, all those limestones that contain a considerable proportion of clay, and particularly if that be ferruginous, afford, when burned, what is called *hydraulic* or *water* lime, because, when made into mortar by the addition of sand and water, such mortar sets hard even under water; on which account it is extremely valuable for building piers, docks, and similar works.

An opinion is very generally entertained among builders, that the harder the limestone, the better must be the lime obtained from it by burning. But this is not strictly true: chalk, when burned in the best manner, as it was by the late Lord Stanhope, makes lime as fit for mortar as the hardest pure limestone, provided it be used for this purpose immediately; but it is a fact of practical importance, that lime made from soft porous stones like chalk absorb from the atmosphere the carbonic acid which they have lost in burning, sooner than lime made from more compact stone; and as chalk lime is seldom secured from the access of air before it is worked into mortar, it has sometimes returned so far to the state of chalk as nearly to have lost its binding quality. Every description of lime should be used as fresh as possible.

The lime used for common mortar in and about London is made from white chalk, often imperfectly burned; but a superior kind is procured from employing the gray chalk of Dorking, which contains some clay, yet not enough to form the best hydraulic lime.

91. *The sand for mortar* should consist of clean, angular, silicious grains, not too fine, and as free as possible from any admixture of earthy substances. River sand is usually the best, or pit sand if it be of the proper size, and not dirty, which it is apt to be, clay or earth of any kind weakening the mortar. Sea sand is improper, except it is well washed to deprive it of the salt that adheres to it, as that would prevent the walls from ever being dry, causing them to attract the humidity of the atmosphere. The sand is passed through a screen or sieve, to reduce it to the proper degree of coarseness; and what consists of very small rounded grains is not so proper as what is rather coarse and sharp. Old and bruised mortar screened, and rubbish scraped off the roads, which some bricklayers are apt to use, are improper.

92. *To form mortar*, fresh-slacked lime is mixed up with a sufficient quantity of proper sand, water enough being added to make it into a tough paste. In mixing the lime and sand together, considerable labour should be used; as it is found that the beating the mortar well, so as to incorporate the materials thoroughly, is essential to make it of good quality, and fit for the mason or bricklayer. The inferiority of modern to ancient mortar has been a subject of frequent remark and regret; and the chief cause is, no doubt, owing to the less care now taken in the selection of the materials, and the less labour bestowed

upon them. The lime employed for London houses is sometimes imperfectly burned; and having been conveyed from a distance of from ten to twenty miles, without any precaution to keep it from the air, it has often lost much of its cementing properties before it is used. This is too frequently mixed with dirty sand, except a surveyor superintends the work; and the whole is merely incorporated with a spade, in a slovenly manner, with too great a quantity of water, to save trouble in beating it.

93. *Hydraulic mortars*, or *water cements*, are, as we have stated, made by using lime from limestones containing clay, generally ferruginous, or from other materials not calcareous, which we shall describe.

Limestones of this kind are found in various countries, though less commonly than pure limestones. In England, the most abundant material of this kind is the *Lias limestone*, which is found in a belt stretching across England from Whitby to Lyme Regis, in Dorsetshire; and it is likewise plentiful round Bath, and in several parts of Gloucestershire. It has long been extensively worked at Watchet, Aberthaw, and Barrow in Leicestershire. The Lias stone, which is found in thin beds alternating with slaty clay, is of a dull gray colour and earthy fracture, containing about 11 per cent. of clay and iron. The lime made from it was employed successfully by Smeaton *in constructing the Eddystone lighthouse, mixed with Pozzolana.* In Bath and other places this, with sand, forms the common mortar, which is excellent. In London it is little used, from its price being 25 per cent. more than that of Dorking lime; but it is employed in a cheap and good stucco. There are a few other substances, not calcareous, that are still superior to those we have mentioned, for their property of causing mortar to harden under water.

Pozzolana is brought from Pozzuoli, near Naples, and consists of volcanic ashes that have concreted into a cellular mass of a baked appearance and rusty colour. It was this material that enabled the Romans to construct those remarkable moles and summer retreats in the bay of Baiæ, the ruins of which may yet be traced in the sea. When mixed in proper proportion with mortar made with common lime and sand, it causes it speedily to set under water, and become as hard as stone, affording the strongest water-cement known.

Dutch tarras or *trass* is another substance nearly similar, which used formerly to be imported from Holland, where it is extensively employed in hydraulic works. This is made from a porous lava found near Andernach and other places on the banks of the Rhine: it is ground to powder, for the purpose of using instead of Pozzolana. Its use here is now superseded by Parker's cement, which will be described among *stuccoes*.

Grout, or liquid mortar, is common mortar made so fluid with water, that when poured on a course of brickwork when just laid, it will run into the joints, and cement the whole together very firmly: this practice is employed occasionally where great strength of walls is required.

94. *Asphalte* is a material lately introduced into building, and which has some valuable properties. It is a bituminous substance, found in various places; but perhaps the best known to us is that brought from the south of France, where it is found near the town of Seyssel, on the east of the Jura. It is there dug as a calcareous stone impregnated with bitumen: this is pounded and exposed to a strong heat, by which the whole is fused or rendered soft; when cooled, it is made to form a hard cement. The asphalte is used in various ways, mixed with sand, gravel, pebbles, &c., according to the various uses to which it is applied. It has been largely employed, instead of stone, in the *trottoirs* or side pavements in Paris and other places; and examples of this kind may be seen in various places in London, which appear to answer very well. This would, no doubt, be imitated oftener, but that our abundance of good stone renders it less necessary to use this resource. It is very useful as floors in offices of buildings of various kinds, being perfectly tight, warm, and impervious to vermin. It is said likewise to form excellent walks in gardens, and succeeds in terraces where damp prevails. It is said to be little inflammable; but it is not used here on roofs, though occasionally employed in this manner on the Continent. There are some other varieties of the asphalte, but it is difficult yet to speak of their comparative merits

Subsect. 4.—*Drains*.

When the plan of a house is completed, one of the first things to be done is to insert that of the *drains*, and to determine in what way the water from the roof and other parts should arrive at the sewers, cesspools, or other places for its reception.

95. *The drains of a building demand great attention* from the architect who plans them in the first instance, and they also require to be kept in the most perfect order, to ensure the safety of the building, and the comfort, and even health, of the inhabitants. It is to be observed, that in the metropolis and its environs it is necessary to comply with the regulations in the Building Act in the construction of the drains, and it is the business of the district surveyor to see that nothing is done contrary to that act. There should be kept in every house (though it is seldom or never done) an accurate plan of all the drains, which ought to be preserved from the time the building was erected; but if that has been neglected, then the first time they have to be repaired or opened, a plan should

be made to refer to at any time. In this not only the course of the drains should be accurately marked, but likewise all the cesspools, stench traps, and sink stones; also the general sewer. It would be still farther useful if sections were made, showing the quantity of slope or current of the drains, their depth below the floor, pavement, &c. For want of such a plan, it is difficult to conceive the trouble which occurs when drains get out of order; and sometimes much unnecessary expense is incurred, and even serious mistakes are made from the bricklayer who may be employed not knowing their true course. Pavements and floors must be taken up and deranged, in order to discover them, or work is carried on erroneously, and fails of its object.

All small drains that it is necessary to open occasionally when they require cleaning out, should be of the form of *a*, *fig*. 23, with concave or arched bottoms, and the tops flat and covered with flag stones or paving tiles set in cement. The concave bottom enables the water to collect better together, and to move more freely than when the bottoms are flat. Barrel drains *b*, *fig*. 23, are the strongest, but as they cannot be opened without breaking them up, they are only used where there is a considerable fall, and where they are not required to be frequently opened. The fall in a drain should not be less than a quarter of an inch in a foot. *Sewers* are generally built of the form represented at *c*, *fig*. 23.

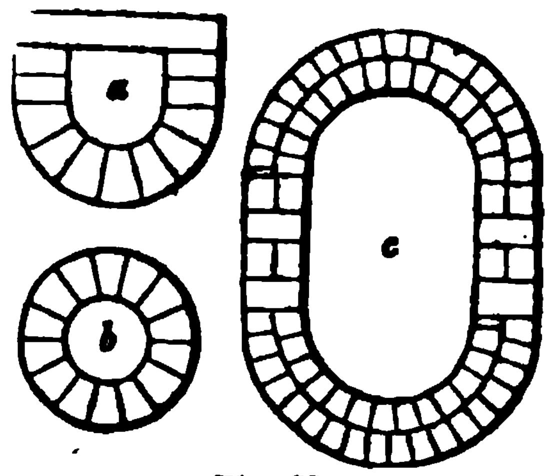


Fig. 23.

96. *It is of great importance that the drains should be executed in a workmanlike manner*, and a proper current given to carry off the water. If they are built in a careless and insufficient manner, the house is very likely to prove forever damp and unhealthy. They should be constructed of sound bricks with Roman cement, and every precaution should be taken to make them perform their office with as little looking at as possible.

97. *When nothing prevents the foul air of drains from coming out* through the apertures by which the water goes down, the consequence is extremely disagreeable, and even injurious to health; and to obviate this effect, the contrivance called a *bell stench trap* is made at every sink. *Fig*. 24, *a*, *b*, *c*, represents the section of a portion of a hollow cone of metal, having a short pipe in the middle *b*, *d*; and water is put into this cone up to the level *a*, *c*. A loose perforated cover, *e*, *f* (see section, and also the *fig*. below) is made to rest on a shoulder on the top of the cone, and this cover is perforated with two circles of holes; on the lower side of this cover a hemispherical cup is fixed, the edges of which dip under the surface of the water. When water of any kind is thrown on the cover, it passes down through the holes and finds its way under the edges of the inverted cup, down through the tube *d*, and so into the drain; but if any foul air should come back the same way, before it gets out it would have to pass through the water; but from its levity it lodges in the top of the hemispherical cup, and cannot descend through the water, except more pressure was exerted than is usually the case; hence the cup dipping into the water is a complete trap or stop for the air, and effectually hinders any bad smell or other noxious effluviæ from coming up from drains, which, indeed, should never be without this simple but useful contrivance. These traps likewise prevent the intrusion of rats, &c. This apparatus, however, is sometimes liable to be deranged by neglect or bad usage; and it is proper to construct another kind, of brickwork. Somewhere in the course of the drain let there be sunk a small square well, *fig*. 25, *g*, *g*, built round with bricks laid in cement, and plastered on the inside with the same, so as to be completely water-tight and remain always filled with water. Across this well let there be a piece of paving stone so fixed that its top may touch the cover of the drain, and its lower edge dip below the surface of the water in this trap or well. On the same principle as the bell trap, no air can pass along the drain, it being stopped by the water below the stone.

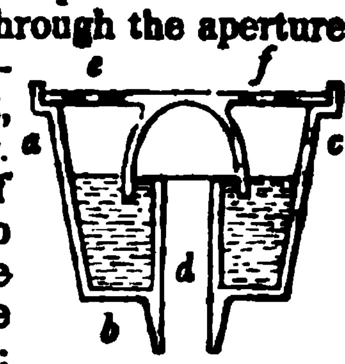


Fig. 24.

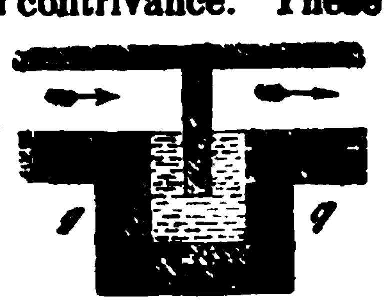


Fig. 25.

A cheap trap may be constructed of common red earthenware, to be used in places where any waste water goes down to a drain. In *fig*. 26, *a*, *b*, *c* represents a piece of coarse pottery, of which the horizontal part, *a*, *b*, is about nine inches square, perforated with holes; from the under side of this the piece *c* projects, and dips into the water that will always remain in the square receptacle *d*, and which will overflow and fall down by *e* into the drain.

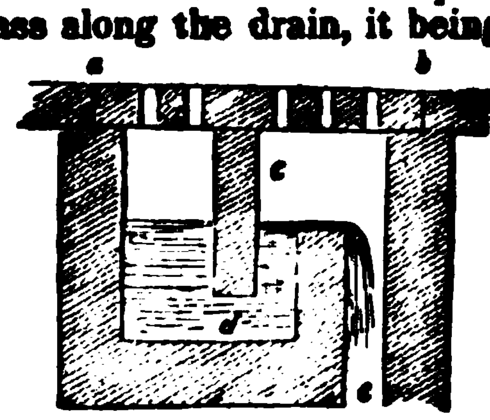


Fig. 26.

In cities and large towns the drains are carried into the common sewers; but in places where there are no sewers, it is necessary to carry the drains to some place where the

water can be discharged without causing a nuisance. Cesspools or tanks bricked round are sometimes sunk to receive what is brought by the drains; but these should be avoided as much as possible, as they sometimes generate foul air that renders the place unhealthy. If used, their situations should be well covered and marked, and they should never be placed near the foundation of a building, but sunk at some distance from it. If the situation admits of it, the drains should empty themselves into some running stream, whence the foul matter may be carried away, or be discharged into some place so far removed as not to injure the air of the dwelling by its noxious effluvia.

98. *The sewers of London*, in modern times, stand unrivalled for extent and excellent construction, and to this must be attributed much of the increased salubrity of the metropolis, although a good deal remains to be done to render them adequate to the wants of so immense a population. The great sewers are placed at such a depth as to drain even the lowest parts of the basement stories, a circumstance which struck with astonishment some engineers who were lately sent from Paris to collect information on this subject. In most cities and towns all that is attempted, in the way of drainage, is to get rid of the mere surface water, and where this is neglected dangerous fevers are the frequent result.

SUBSECT. 5.—*Foundation.*

99. *To secure the strength and stability of an edifice*, the *foundation must be laid in a sound and substantial manner;* and yet this is too often executed very negligently, from which result settlements and cracks in the walls, defects generally incurable, except at a vast expense, and endangering the safety of the buildings. A house built upon a rock is proverbially safe, but all rocks are not good to build upon, only such as are of a firm texture. Some knowledge of the geological structure of the country would be useful, in enabling the architect to judge well of the nature of the ground; sometimes boring to some depth will be prudent, and every precaution should be employed to avoid errors and failures in the foundation. It is a good rule never to trust to "made ground," that is, such as has been disturbed by man, but to dig the trench for the foundation down to the original stratum; because no earth that has been once disturbed ever becomes so firm as at first. No ground where there are natural springs should be built upon, except great care be taken that they are well determined and arched over. Clay, gravel, or even sand, may make a very solid foundation, provided their original beds are reached, and there be no springs to affect them. All London is built upon sandy gravel, and the foundations are sufficiently durable when they have been built properly.

100. *No general rule for the depth of foundations can apply to every case*, such as that given by Palladio, that they should be one sixth of the height of the building; but this must be regulated by local circumstances. To ascertain the nature of the bottom, the ground should be struck hard with the hammer; if it shakes, it is loose; if small parts only are soft, they may be removed, though it is best to have all the foundation level. When, notwithstanding, the ground is not thought sufficiently firm, recourse must be had to some precautions. Piles may be driven, and over them oak planks may be laid; or planks alone may be put in the bottom of the trench: charring the outside of these will make them endure longer. Large blocks of stone may likewise be laid down, particularly at the corners.

101. *If parts only of the foundation are soft*, arches may be turned from one hard spot to another. But the best method of securing the foundation is that which is now very generally practised, namely, to fill up a certain depth of the trench with what is termed *concrete*, or pebble mortar, which is composed of thin mortar made with lime newly slacked, and clean pebbles or stone chippings; when this becomes hard, which it does in a short time, the whole foundation seems as if composed of a rock, which may be built upon without fear of any cracks or settlements. This kind of mortar is by no means a new invention, though its use has been of late revived; for it may be seen in our old castles and other buildings of great antiquity.

SUBSECT. 6.—*Walls of Brick and of Stone.*

102. *The choice of materials for walls* must, in some degree, be determined by the locality, the comparative price, the style of the structure, the objects in building as far as duration is concerned, and many other points which may vary with different individuals.

The materials in general use are brick, stone, and earth or Pisé. The Building Act requires that the materials of walls should be of brick, stone, or artificial stone, and no timber to be used in them, except such as is necessary for planking, bridging, or piling the foundation; and for templets, chains, and bonds, and also the ends of girders, beams, purlins, binding and trimming joists, or other principal timbers, observing always to leave 8½ inches of solid brickwork between the ends and sides of such timbers and the timbers of adjoining buildings.

103. *The thickness of walls* must, of course, be regulated by the height and number of stories in the mansion, and the materials, whether of stone or bricks. It is to be observed that in brick walls the thickness is, in some degree, regulated by the size of the bricks: thus a wall may be 1, 2, or 3 bricks, or 1½, 2½, 3½, &c., but it cannot be 1¼, 2¼, &c., since the bricks cannot be cut properly. In stone walls there is no such limitation.

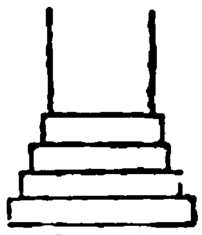


Fig. 27.

104. *The lowest part of the walls is technically called the footing*, which should be considerably thicker than the wall above, diminishing to that of the walls by a set-off in each course as it rises. This, as well as the thickness of the wall, is regulated by the Building Act, and there can be no better rule than to attend to its instructions, even when the building is out of its limits. In the first, second, and third rates, the footing must have a width at least nine inches more than the thickness of the wall above, and the top of it shall be at least six inches below the surface of the lowest ground or adjoining area, and at least 12 inches below the surface of the lowest floor in the house.

105. *Party walls* are those which divide one house from another; they must be built with good bricks, and the Building Act is very particular in requiring them to be of a certain thickness, according to the several rates. No external wall can be converted into a party wall.

106. *When stone is employed*, the architect must be guided partly by the strength of his materials. The operation of preparing the scaffolding, and raising the wall with strict adherence to the dimensions marked in the working drawings, are subjects of too technical a nature to be entered into here, and must be left, in a great measure, to the skill of the tradesmen, superintended by the surveyor. A few general hints may be mentioned as things to be attended to. Care being taken to provide the best bricks and mortar, and that the bricklayer uses what is technically called the proper bond in building, the wall should not be run up too hastily, although most persons are desirous of expedition; in particular, one part should never be worked up higher than another above a few feet at a time, since all walls settle or shrink a little when newly built, on account of the softness of the mortar, and if the work be carried up too rapidly, cracks are apt to occur from unequal settling.

107. *In dry weather it is useful to wet the bricks* before they are laid down, in order that the mortar may adhere to them better; and care should be taken that the bricklayer fill in properly the cavities that may happen in the centre of the wall, which they are apt to neglect. Walls should not be built in frosty weather, since, if the mortar should happen to freeze while it is wet or new, it will, on thawing, crumble, and its adhesive property be totally destroyed; therefore such wall will have no strength or durability. In stormy and rainy weather, the top of the new wall should, if possible, be covered with straw or boards.

108. *Sound materials should be used in the lowest part of the wall*, although, from this part being concealed, it is too often the practice to introduce materials of inferior quality. Place bricks should never be permitted, and only the hardest stocks employed: if they should be somewhat overburned, so as to be in some degree vitrified, and unfit for the upper part of the wall, they may do well in the foundation. When there are piers in the wall which have to support great weights, it may be proper to turn reversed arches, as in *fig*. 28, to distribute the pressure properly and prevent settlements.

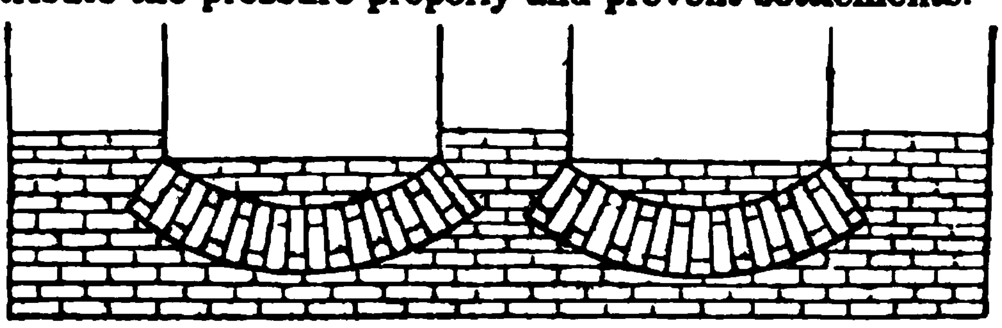


Fig. 28.

109. *When walls are required to be very strong*, it is a good practice to pour some liquid mortar, or *grout*, on the brickwork at every five or six courses which will fill the joints, and set very firm. Also to prevent any damp from rising in the basement story, which, in some situations, is apt to be the case, it is well to lay a couple of courses of bricks in Roman cement, or asphalte, a little above the foundation, as this will prove impenetrable to the wet; or a row or two of strong slates imbedded in cement may be laid in the same place. It should be a rule never to be broken, that the earth should not be suffered to lie against any part of the wall of the basement story; since, if it does, that part of the wall is sure to be always damp within: an area, more or less wide, should be dug out quite round the building. Kitchens are sometimes rendered unhealthy and scarcely habitable, and the whole house affected by damp and bad air, from neglect of this precaution.

110. *The wall over all openings*, such as doors and windows, is supported on the inside by lintels of timber; but on the outside by brick arches. These are of various kinds; *a*, *fig*. 29, is a semicircular arch, the strongest of any. *b*, is a flag segment arch, executed over windows in houses of the most ordinary kind of brickwork. *c*, is an arch used where great strength is required; a wooden lintel is put over the open-

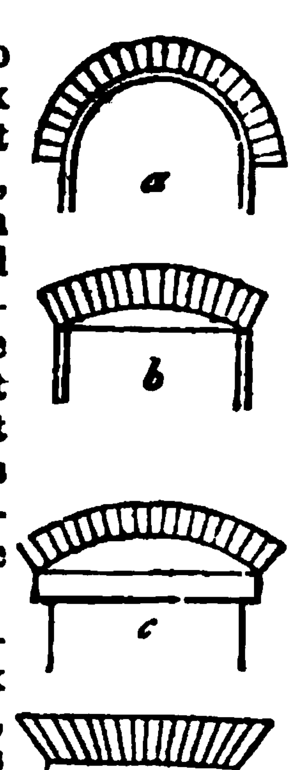


Fig. 29.

ing, and a segment arch placed thus to relieve the lintel from the superincumbent weight. *d* is the mode of forming the brick arches in houses of the best class. here the lower part of the bricks forms a straight line instead of a curve, and the bricks are cut and rubbed so as to be all of the wedge form: these last are termed *gauged* arches, and require to be very well set with a small joint, otherwise the bricks give way and fall down.

111. *The stone sills of windows* are those pieces at the bottom (*a*, *fig* 30) which project from the wall about two inches to turn off the rain, and prevent it from running down on the wall. These are always left out until the brickwork has had time to settle completely; for, as the piers on each side of the window press, by their weight, more than the brickwork immediately under the opening of the window, if the stone sill were to be put in while the brickwork was in the act of settling, the two ends of the stone would receive more pressure than the middle, and would consequently break. After the wall has completely settled, or, as it is called, "come to its bearing," the stone sills are put into their places.

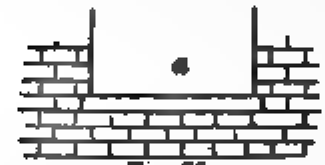


Fig. 30.

112. *The coping* of walls is the course of stone that is put on the top, and it is very important that this should be of a good material. Portland is the best of what is used in London. Yorkshire stone is put in inferior houses.

113. *With respect to the manner of building walls*, in the best houses where the facing is of stone, the latter is squared, hewn, or rubbed, and laid with regular joints. The inside of the wall is sometimes of brick, or rough stone, and the outside casing of smoothed stone, termed *ashlar*; in this case the ashlar should be well bonded with the backing. Even when the walls are of brick, stone is required for certain parts, as kerbs, steps, landings, columns, string courses, cornices, coping, balustrades, and paving of halls, &c., though some of these are now executed in Parker's cement.

114. *Walls built with stones not hewn*, and brought to a smooth face, are called *rubble walls*; and they may be uncoursed or coursed, and be laid dry, or with mortar. When uncoursed, the stones are used of all sizes as they come out of the quarry, the interstices of the large being filled up with smaller ones (see *a*, *fig*. 31), and sometimes they are hammer dressed on the face. When the wall is coursed, the stones for each course being selected of the proper size, and rough dressed, they are laid as at *b*. This mode of building is much used in country places, where stone is plentiful, and the mason's work may be covered with stucco or rough-cast.

Fig. 31

115. *Pisé*, or earth compressed in mould, is a material very common in some parts of France, and houses built in this way are both warm and comfortable; but it is little employed in this country. Walls of mud and straw are confined to cottages, and are not to be recommended.

SUBJECT. 7.—*Chimneys*.

116. *The situation of all the chimney fireplaces having been determined in the ground-plan*, the bricklayer proceeds to set them out with care, and the carpenter to lay his joists accordingly.

117. *The Building Act requires* that there shall be no timber over the opening of any chimney for supporting the breast, but that there shall be an arch of brick or stone, or an iron bar; and no timber shall be laid in the wall under the hearth of any chimney nearer than eighteen inches from the surface of the hearth. The hearth of every chimney shall be laid on brick or stone; and the chimney shall have a slab of stone, marble, iron, or tile, at least eighteen inches broad, and one foot longer than the opening of the chimney; such slab shall be laid upon brick or stone trimmers. In party walls there is to be thirteen inches of brickwork between the backs of chimneys on each side of the wall.

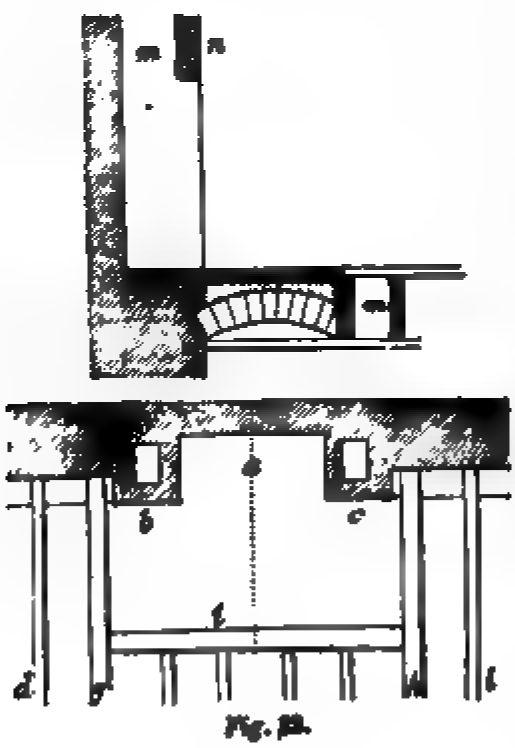


Fig. 32.

118. *a, b, c* (*fig*. 32) *represents the plan of a chimney*; *d, g, h, i* are the joists, and *l* is a short joist called a trimmer, let into the trimming joists *g* and *h*, at the same distance from the wall as the marble slab is to come into the room. This trimmer is shown at *m*, in the section above, supposed to be taken through the dotted line in the plan. The

use of this trimmer is to support the end of a very flat brick arch, seen in the section, extending from the wall; this arch must be so flat as to be wholly included, together with the thickness of the hearth, in that of the floor. The breadth of the brickwork of the chimney at *b* and *c* is obliged, by act of Parliament, to be such that no woodwork may lie nearer to the flues than nine inches. The whole of the hearth and slab thus rests upon bricks as a security from fire. The depth of the chimney in the wall is left to the architect; but it is generally from two feet six inches to eighteen inches. The thickness of the brickwork of the chimney breast, *n*, has been usually four inches; and it is supported upon a slightly curved iron bar. No flue is now permitted to be built with an angle less than 135 degrees, unless the same shall be provided with proper openings, not less than nine inches square, and proper close iron doors, and frames inserted in such openings, whereby such flue may be swept by machinery; and every salient or projecting angle within such place shall be rounded off four inches at least, and shall be protected by a rounded iron bar. See Sect. 10, Book II.

119. *Perhaps no parts in building, requiring great care, have been constructed with less care* than chimneys, fireplaces, and flues. The inside of the latter has been daubed over with a kind of mortar, having in it a mixture of cow-dung to prevent its peeling off, but which is liable to come off in sweeping. Were the form of flues circular in the plan, instead of being rectangular, as they almost always are, they would be more easily cleaned, there being then no angles for the soot to lodge in, and they would likewise draw better; but, in that case, a particular form of bricks must be employed, except the bricklayer could manage with the ordinary brick and Parker's cement, with which the inside should be made perfectly smooth. But since the practice of sweeping chimneys by climbing boys is abolished, many improvements will, no doubt, be made in the construction of flues. For the construction of chimney fireplaces, see Book II., "On Warming Domestic Edifices."

120. *Chimney tops.*—These are often neglected by the architect, and left to the bricklayer. Nothing can be more unsightly than the appearance of a plain stack of chimneys carrying a row of common red chimney pots, as *a*, *fig.* 33. Much more taste was displayed by our ancestors, who, in old English mansions, designed the chimney shafts in an ornamental manner, that is now imitated in Elizabethan or Gothic houses; but the style of a Grecian edifice demands different designs. The architect, however, should avoid the usual absurdity of a finishing cornice supported by modillions of any kind, as at *a*, since these represent the ends of joists, an idea entirely inconsistent with the nature of a chimney shaft. Chimney pots are frequently made square, as at *b*, and have a better effect than the usual round ones, which, independently of their form, have a character of meanness, derived, perhaps, from association of ideas, which condemns them to the poorest class of houses. The cowls to prevent smoke, too often disfiguring them, are proofs of ill-constructed chimneys, except, indeed, there are local circumstances that may excuse the builder.

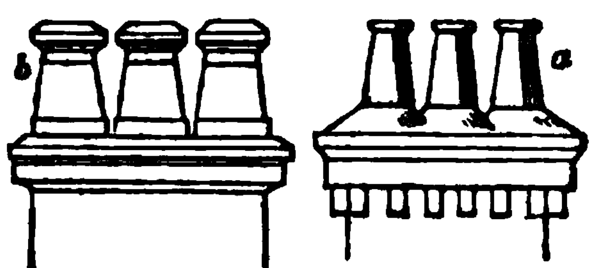


Fig. 33.

SUBSECT. 8.—*Pointing Brickwork.*

121. *Pointing* is filling in the joints of the brickwork with mortar, or restoring this when it has been attacked by frost while the building has been going on, or where it has become decayed through time. The old mortar is first raked out by the labourer; the bricklayer then wets the joints with a brush, and fills them up with mortar containing a proportion of black scales from the smith's forge, which makes a very hard, dark *blue mortar*; or Parker's cement may be used: this is called *flat* pointing. If great neatness is required, the whole wall is well washed and coloured before the pointing is done, and a very neat straight line is also added by white putty, and cut very smooth, which is termed *tuck pointing.*

SUBSECT. 9.—*Stuccoes and Rough-cast*

122. *Stuccoes.*—These are compositions with which walls are coated, to produce an imitation of stone; but it had long been found very difficult to form a durable stucco for the external parts of houses in this country.

123. *The excellent stucco now familiarly known in London by the name of Roman cement,* is improperly so called, because it is not the cement used by the Romans. Its original name of *Parker's cement* should be retained, because it was a discovery made by Mr. Parker about forty years ago, who still manufactures it. Certain nodules, consisting of indurated clay with some lime and iron, known long to geologists by the name of the Ludus Helmontii, or Septaria, were found by him to possess the property of setting very hard when burned and ground to powder, and made into a mortar mixed up with lime and sand: this mixture becomes hard in a few minutes; so quickly, indeed, that no more of the cement can be used at a time than can be worked up with the trowel or other tool immediately, as it sets almost under the workman's hands. When properly executed, it does not appear ever to fail, or scale off the walls, as almost all former stuccoes were found

to do, sooner or later. And not only is it used for the surface of the walls, but it is worked into cornices, mouldings of all kinds, and, in short, into all the ornaments and enrichments, even of Gothic architecture, where stone alone could formerly be employed. It is the most perfect water cement in common use in this country, and is used in all cases where a superior material of this kind for building is required. The nodules from which it is made are found chiefly in the London clay at the Isle of Shepey; but they occur likewise at Harwich, and at Whitby in Yorkshire. It is to be observed that this stucco will not stand the fire, and therefore should not be employed in setting grates, or in any places to which the fire has access. All limestones having a considerable proportion of clay and iron will afford a somewhat similar material: accordingly, a pretty good stucco is made from the lias limestone; but, though cheaper, it is inferior to Parker's.

124. *Hamlin's mastic* is another cement having valuable properties. It is an invention of Loriat of France, a century ago, though patented here. Linseed oil is used in it, and being extremely beautiful, it is sometimes used to cover Parker's or other cement in a thin coat. It is very durable, but expensive. It has one advantage, that when applied to the walls of apartments, they may be papered immediately.

125. *Martin's patent cement* is a new composition which is described as having some good properties. It can be made to imitate Portland stone or coloured tessera, as well as marble. It is perfectly hard, and extremely durable. Mouldings can likewise be easily formed with it, and, consequently, walls may be paneled. It is of moderate expense.

126. *Keene's patent marble cement* is a late invention, and appears to be approved of. It is of various kinds. The coarse qualities form a paving not distinguishable from stone in colour and hardness, but at less price; one variety is a close imitation of marble. Our limits will not permit us to describe various other stuccoes that have been invented and tried, which is the less to be regretted, since most of them have failed, and are of little use.

127. *Rough-casting* is a cheap and durable method of finishing walls instead of stucco, and is well calculated to protect them from the effects of the weather, but is chiefly employed in small houses and cottages in the country built of rough stone or rubble. There are two kinds of rough-cast. In the first, the wall receives a coat of lime and hair laid on smooth; and as fast as a certain portion of it is covered, the rough-cast is thrown or splashed against the wet mortar with a large trowel. This rough-cast is made by reducing very fine gravel or coarse sand to a uniform size by sifting or screening, and washing the earth away from it. This is mixed with newly-slacked lime and water to the consistence of thick cream. When the plasterer has covered a part of the wall in the manner mentioned, he brushes it over with a whitewash brush dipped into the pail with the rough-cast, so as to lay the whole smooth and even. The intense white of the lime is unpleasant to a person of taste, although, in some parts of the country, many delight in it; but this white glare may be easily softened, and a stone colour produced, by putting into the mixture a sufficient quantity of yellow or stone ochre, or Spanish brown, or ochre with brown or black, to produce the desired tint. It will be necessary to try the colour on a board or a part of the wall, and to let it dry to determine the exact tint, and to put more colour or more lime and sand till the tint be adjusted. Either a sufficient quantity should be made for the whole building, or very great care must be taken to get the same tint in every quantity that is used, or the colouring will look patchy; and it is to be observed that the tint given must be very light, otherwise it may be worse than pure white.

Another method of rough-casting is also used. Upon the first coat of lime and hair there is thrown, while it is yet in a soft state, a quantity of very small angular fragments of stone, as limestone, granite, &c. These fragments being pressed, stick in the mortar, and are firmly fixed there when the latter is dry and hard. This mode is much practised in Bristol, where broken spar from the quarries gives a rich glittering appearance to the houses done with it.

128. *A colouring for outside walls* may be made of fresh-slacked lime, to which a little sulphate of iron added will give a warm tint. This colouring is useful for a brick house that has become black and dirty: it should be done before the wall is fresh pointed, and if the tint be well chosen, the house will look nearly as if just built.

Painting stone or stuccoed walls with oil colours has been found sometimes a good practice, and preserves them very much.

129. *Limewhiting* is a wash made by mixing quick-lime with water alone, and laying it on with a large flat brush: it is used for areas and similar places. If required not to be capable of being rubbed off, some coarse size may be added.

An excellent lime-wash for walls or boarding of out-houses or cottages may be made as follows: Half fill with water a tub of six or eight gallons, and add to it as much of clean, sharp, and rather coarse sand, and of Dorking lime fresh burned, in about equal quantities, as will make, when it is well stirred up and mixed, a wash of about the thickness of cream. Lay this on the walls with a large brush, taking care to stir up the mixture every time the brush is dipped into it, so as to take up as much sand as possible. The

more fresh the lime the better, which, if good and proper for the purpose, will mak water hot.

SUBJECT. 10.—*Carpenters' Work.*

130. Though the bricklayer is the first artificer who begins, yet the carpenter very comes into action. In the building business a distinction is made between the arti in wood who assist in forming the carcass, and those who execute the finishing i same material. The first are termed *carpenters*, the latter *joiners*.

131. *Timber.* The only kinds of timber in common use for building in this countr oak, and fir or wood of the pine tribe; the former is by far the strongest and most ble, but likewise most expensive.

132. *By far the best oak is of English growth.* There are two varieties of it, the *cus robur*, or common oak, the most abundant; and another much more rare and known, *Quercus sessiflora*, distinguished from the former by having long foot-stalks leaves. It is said that the latter had been employed in some of the oldest wooden in England, which are usually supposed to be of chestnut. English oak is chiefly ployed in ship-building, but it is likewise used in domestic buildings whenever strength or durability is required. It is the only timber that can be depended upo ground joists, except the soil is particularly dry; and it is not liable to be attacke worms, from the gallic and tannic acids which it contains. It is also used in wi and door sills, and in all such parts as are very liable to be decayed by the weath damp. It was formerly much more extensively used here before *fir* was introduced may be seen in the internal finishings and carvings of ancient houses. The varieti foreign oak are very considerable, and some of them are imported. An American sp brought from Canada is much inferior to English oak, being light, spongy, and not dur Oak is likewise brought from Norway. A kind of oak called *wainscot* is now much ployed in finishing and furniture; this is of a lighter colour, and comes down the R being imported from Riga. Oak flourishes best in clayey soils; and it is remarked, the slower the growth the more durable is the wood.

133. *The terms fir and deal* are applied to the wood of the pine tribe, which is par larly the "builder's timber," as oak is that of the ship-carpenter. The name of applied to logs which are only squared with the axe, and to the various scantlings s out of them for girders, joists, roofing timbers, &c. When the wood is sawed int form of planks, these are called *deals*; whence this name, which properly belongs to the form, is often applied to the material itself. Vast forests of pine exist in north of Europe, on both sides of the Baltic, in Norway, Sweden, Russia, Prussia, land, and Germany, from whence the timber is shipped for us in the ports of the B and Norway. The best fir is known to us by the name of Dantzic, Memel, Riga, from the ports where it is shipped under the name of spars and masts; and the deals are brought in vast quantities from Christiana in Norway, as well as other pl in Scandinavia.

134. *There are two kinds of pine wood principally in common use;* the red or yellow the white. The first is the wood of the *Pinus sylvestris*, or common Scotch fir, w containing a great deal of turpentine, is the most durable; this, when sawn into d is used in work where strength and durability are particularly required; for instance best deal floors are laid with yellow deal. *Battens* are a narrow kind of flooring bo *Planks* are very wide and thick deals, used for various purposes. White deal is the of the *Pinus Abies*, or spruce fir, and contains less turpentine than the yellow; hen is not so durable; but being easier to work, and less liable to warp, it is particularly ful to the joiner, and is also the cheapest. A great deal of Scotch fir grows in the r of Scotland, where it is sawed up for use in that country, but this does not come int English market. A few other varieties of fir are grown in various parts of Britain, are employed in agricultural erections, but as they are not common in the building bra we need not enumerate them. We may, however, except the larch, *Pinus larix*, w is now extensively planted in Scotland, and proves an extremely durable, as well as b tiful wood.

135. *The American pine* (*Pinus Strobus*) brought here from Canada is light, soft, of a clean grain, belonging to the white pines; hence it is very useful as deals in n parts of joiners' work, particularly as it may be had of extraordinary widths; but not strong when used as timber.

136. *Other kinds of wood* occasionally used in building will be described under "M rials for Furniture."

137. *Preservation of wood.* It is not only necessary that timber of the proper should be employed, but that it should be well seasoned, by drying, before it is put the building, and no part containing sap should be admitted. Neglect of this frequ is the occasion of the disease called the *dry rot*, which is a decay of the wood, conne with the growth of a minute plant belonging to the tribe of fungi, which, finding th favourable situation, spreads with wonderful rapidity, and, feeding upon the juice o wood, reduces the fibres to an extremely brittle state, so as to be useless as a sup

and if this be not stopped, the rot will in time seize upon great part of the woodwork through the building, and cause its destruction. As the growth of these plants is promoted by confined air, a free circulation of air prevents it; it is proper, therefore, in buildings of considerable magnitude, to provide for this by having small openings in the wall to allow the air to circulate freely round the principal timbers: these apertures are closed on the outside by iron gratings. When the dry rot has commenced its ravages, these can only be put a stop to by cutting out every part in the least affected, and replacing them by new and sound materials. It is also useful to char all wood so introduced, and to wash it and all the neighbouring places with a solution of sulphate of iron. Timber to be used for building is, in some cases, impregnated with a solution of corrosive sublimate, according to Kyan's patent, which is said to prevent this disease; but as this is expensive, it is best not to trust to this or any other preventive.

138. *It is desirable for durability* that there should be as little woodwork as possible in walls; since, if any of the strength is made to depend upon wood, should this decay, the failure of the wall must be the consequence.

139. *In all modern brick houses, a quantity of timber called bond timber* is let into the walls, to equalize the pressure, and tie the whole together; for brickwork alone, as it is executed in modern days, would not be sufficient. A good deal of the strength of the walls depends upon the bond timber being in sufficient quantity, and properly placed. In cheap houses, built on speculation, the builder is too apt to be scanty in this part of the work; and sometimes the timber is not of the best quality; when it decays, the safety of the brickwork is endangered. Bond timber is seldom requisite, and is not desirable, in the basement story: in the parlour story there are generally two or three tiers of it; and the timber is cut so as to agree with the thickness of the bricks. Pieces of this bond timber, or of oak, called *wood bricks*, are also sawed into short lengths, or that of a brick, and inserted in various parts of the walls, for the purpose of nailing parts of the joiner's work to; where that is neglected, it is frequently necessary to drive strong wooden plugs into the wall to supply the want; but this is apt to shake and loosen the wall. Besides the regular bond timber, timbers of larger size or scantling are laid at the top of each story, to receive the joists of the story above it. These are termed *wall plates*; and care should be taken that each tier is united together so as form an entire chain round the building, except where the chimney flues come; and that they are properly secured at the corners. The bond timbers are carried across the windows at first, and are not cut out until the carcass is thoroughly dry, and the walls come to their proper bearing.

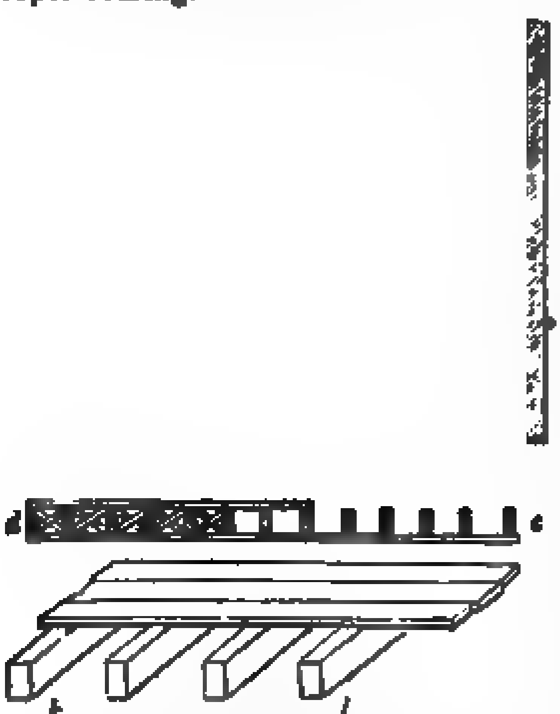


Fig. 34.

140. *Floor timbers.*—In England floors are almost always made of wood, and are supported by beams called *joists*. At the completion of each story by the bricklayer, the carpenter puts down the various timbers of the floor, technically called the *naked flooring*. These consist of various arrangements, according to the degree of strength required, and the size of the apartments. When the apartments are small, *single flooring* may be sufficient. This consists of joists usually twelve inches apart, simply laid from one wall to another (*fig.* 34), or to a partition, their ends resting on the wall plates; the flooring boards being nailed upon the upper edges of the joists, and the ceiling on the lower. The depth of the joists is made several times their thickness, for greater strength, but the latter should never be less than two inches. *a* and *b* are the *trimming joists*, a little stouter than the rest, to receive the trimmer *c*, that supports one end of the brick arch called the brick trimmer, as has been already explained under chimneys. This kind of floor may be made considerably stiffer and stronger, if required, by putting *struts* between the joists in the manner shown in the section *d e*. These struts are short pieces of wood, about an inch thick and three inches wide, nailed on to the joists, and ranged in straight lines across the floor, as at *f g* and *h i*, the distances between the rows being about five or six feet. In this kind of flooring the ceiling is apt to crack. *k l* is a perspective view of a portion of this floor.

141. *Double flooring* is superior to single, in not letting the sound pass through so easily, and being better for the ceilings. They are formed by first laying down beams across, from wall to wall, called *binders*, *a b* and *c d*, which carry the joists, then termed *bridging joists*, see *fig.* 35, plan, section *e f*, and perspective view *g h*. The binders are usually placed about six feet apart: the ceiling joists on which the laths for the plastered ceiling are nailed, are let into these.

142. *Double framed flooring.*—*Fig.* 36, plan, section, and perspective view, is where a

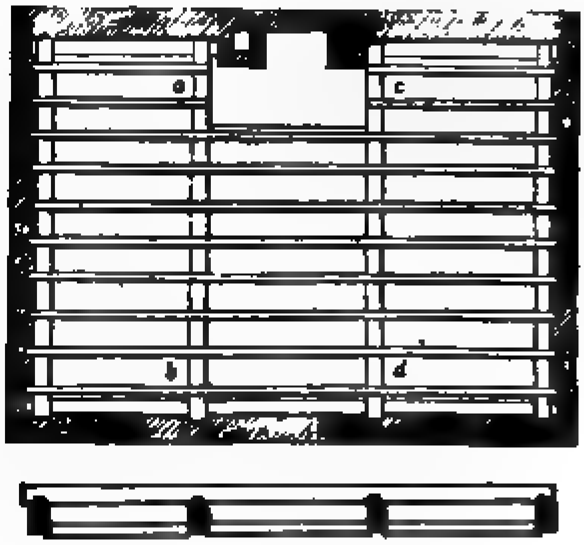


Fig. 35.

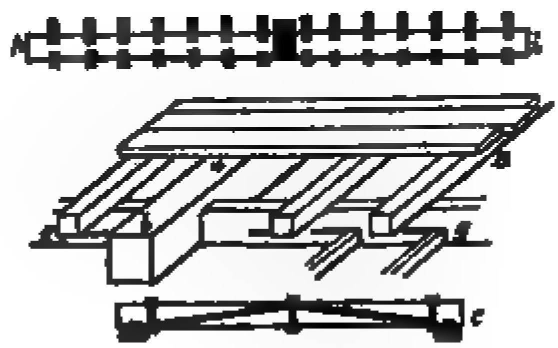


Fig. 36.

very strong beam, *a b*, called a *girder*, is used to shorten the bearing, when the size of the room is too large for binding joists alone.

In very large rooms, where a girder, consisting of a single piece of timber, would not sustain the weight without being somewhat bent, it is stiffened by what is termed being *trussed*. The usual truss consists of two pieces of oak, placed at an angle, on the same principle as the rafters of a roof, and inserted between the two halves of the girder, sawn down through the middle, and afterward bolted together with the truss between, as at *c*. The whole is then put down upon the walls, as at *a b* in the plan, and acts as a single very stiff piece. Other modes of trussing are in use.

Into this girder the binding joists *d e* and *f g* are framed, and upon them are placed the bridging joists, the ceiling joists being beneath, as in the section *h i*, and perspective view *B*.

143. *The scantlings, or thickness of the floor timbers, are regulated by the Building Act.* No joists of any floor, or rafters of any roof, or quarters of any partition, are permitted to be framed more than twelve inches apart; and no joists of any floor shall have a bearing of more than fifteen feet, and no beams or girders of any floor shall be laid so that the joists bearing thereon shall have a longer bearing than twelve feet. The scantlings of floor timbers are to be as follows:

Joists with a bearing of							
6	feet to	8	feet shall be at least	6½	inches deep, and	2	inches thick.
8	"	10	"	8	"	2	"
10	"	12	"	9	"	2¼	"
12	"	15	"	10	"	2½	"
Beams and girders with a bearing of							
9	feet to	12	feet shall be at least	9	"	6	"
12	"	15	"	10	"	7	"
15	"	18	"	11	"	8	"
18	"	21	"	12	"	9	"
21	"	24	shall be cut, reversed, and bolted, and at least	13	"	10	"

144. *The floors of many kitchens and other offices* in the basement story are paved with stone, for which Yorkshire slabs are generally used; but where greater comfort is required in a small house, the floors are laid with boards nailed on joists, called *ground joists* or *sleepers*, which, however, should never lie on the ground, but should always be supported hollow upon brick walls a foot in height, to prevent the floors from being damp, which they are sure to be when the joists are laid upon the earth, the consequence of which is their decay in a short time. Ground joists are best of oak. Wood should be avoided as much as possible in the basement story: the skirtings are sometimes made of slate, cut and ground smooth for the purpose: this material is capable of being

advantageously applied in many parts instead of wood; or some kind of hard stone may be used.

145. *What is termed pugging the floors* is very useful as a security against fire, and to prevent sound being heard through them. Slips of wood of an inch square are nailed on the inside of all the joists, two inches from the bottom, and other similar slips, three inches from the top; a layer of short pieces of laths is laid between each pair of joists upon these slips, and is covered by a coat of lime and hair: by these means hollow spaces are left between the flooring boards and the ceiling below, which confines the air sufficiently to deaden the sound, and, in a great measure, to prevent the spreading of combustion.

146. *Partitions.*—Some partitions are entirely of brick, where strength requires it, or where a short bearing for the timbers of floors is necessary; but as these take up much room and are expensive, the most usual kind in ordinary houses consists of upright pieces of wood sawn into small scantlings, technically called *quartering*, placed about a foot apart, and covered with lath and plaster. The spaces between the quarters are sometimes filled up with bricks laid flat, which is termed *brick-nogging*. In other cases, the bricks are omitted. When the partitions are required to be very long to carry weights, they are trussed or stiffened by braces, *fig.* 37. Partitions in houses of an inferior kind are formed only of wainscotting, which has the great inconvenience that the voice is easily heard through it. The same thing happens in some cases where the quarter partitions are left hollow: and to prevent sound, as well as to check the rapid spread of fire, if they are not brick-nogged, it is best to treat them nearly in the same way as we described in the pugging of floors, only one layer of laths and mortar may be sufficient.

147. *Roof.* The design of the roof comes from the office of the architect, but its execution rests with the carpenter.

When the domestic edifices of this kingdom were constructed chiefly of timber, about two hundred years ago, the carpenters were not so well skilled in the art of cutting out and placing their beams, with a view to economy and strength, as those of the present day; and the walls were often unnecessarily loaded with a profusion of this material in the floors and roofs. The science of carpentry is now better understood, and strength is made to depend upon judicious framing, combined with lightness, using as little as possible of so perishable and expensive a material as wood. Proportioning the scantlings or thicknesses of the timber just to the strength required, demands the exercise of considerable skill and experience; an inch more or less in the scantlings materially affects the cost and the strength of the edifice; but we need scarcely observe that any excess is best on the side of safety. These scantlings are now regulated by the Building Act.

In many countries where there is little rain, as in Egypt and Asia Minor, the roofs are made quite flat; but in Europe, in general, they slope from one side to the other, or form a raised central ridge between the side walls. The angle in which the two opposite sides of the roof are thus raised is technically called the *pitch of the roof*. In the northern parts of Europe the pitch has always been more acute, and consequently the height of the roof more considerable than was the custom among the Greeks and Romans, heavy falls of snow demanding a high pitch. From this cause, the roofs of ancient buildings among us were higher than they have been made since our taste has been influenced by Italian and Grecian architecture. At present it is thought to look best to make the pitch very low; but if this is carried to excess, it is difficult to prevent the wet from insinuating itself between the joints of the slates and tiles, except they are filled with cement.

148. *Construction of the roof.* If the rafters *a*, *b*, in A, *fig.* 38, abutted simply against the walls without any *tie beam*, *c*, it is evident that any weight laid upon them would have a tendency to cause them to open and thrust out the walls, which, in ordinary buildings, have not sufficient strength to resist, it becomes necessary, therefore, to prevent this effect by having a beam *c* connecting the ends of the rafters, which then can, by their thrust, only stretch this beam like a cord; and the latter is, on that account, called the *tie beam*. In that case, the whole triangle seems like one piece, and the weight of the roof acts only perpendicularly on the walls without any lateral thrust. This is the first simple principle in forming a trussed roof. When the building is very small, and height in the interior is wanted, instead of such a tie beam, the lateral thrust may be, in a great measure, prevented by a horizontal tie kept up higher, as at B, *fig.* 39, called a *collar beam*; but this will answer only in small roofs.

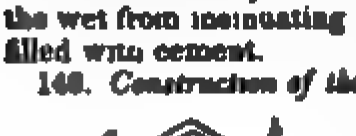


Fig. 38.

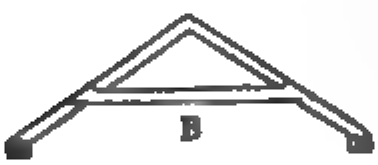


Fig. 39.

In larger roofs a more complicated structure is required, which is represented in *fig.* 49. At certain distances, generally every six or seven feet, the rafters and tie beams are made stout, and connected together by trussing; these are called *principal rafters*. Perpendicular pieces, *a*, called *king posts*, rise from the centre of the tie beams, *b c*, and struts, *e d*, extend from the foot of the king posts to the principal rafters framed into the top of the king posts and tie beams. On the back of these principal rafters, and extending horizontally from one set of them to the other, is a piece, *f g*, named a *purlin*, which supports the common rafters, *h i*, *h i*, the upper ends of which are nailed to the *ridge piece*, *k*, and the lower ends secured to the horizontal *pull plate*, *l*. The end of each tie beam, *b c*, rests upon the *wall plate*, *m*.

Fig. 49.

149. *By the Building Act, no water is suffered to drip* next any public way from the roof of any building, except from the roofs of porticoes or other entrances; but to be conveyed by metal pipes, or wooden trunks, or brick or stone funnels, into drains or reservoirs.

SUBSECT. 11.—*Smith's Work.*

150. *There is a certain quantity of iron in every house*, and to execute this there is the blacksmith and the whitesmith. The first makes such articles only as do not require filing, grinding, or any process that renders his work bright, but finishes everything off on the anvil, as in the making of cramps, iron ties, bars, railing, chains, &c. The whitesmith makes and finishes articles of iron and steel, that are to have a bright surface by means of the file and turning lathe; to him, also, belongs the making and repairing of locks, bell-hanging, &c. The carpenter has occasion for the blacksmith to make a great variety of iron ties, straps, bolts, nuts, and screws for his work, which are always of wrought iron, and for all of which he gives him the necessary directions. The joiner also requires various articles of iron for his work, as well as bars and other fastenings for doors and windows. Most of the articles made by the whitesmith are purchased from the ironmonger. Iron has, of late, come much into use in many parts of buildings that were formerly constructed of wood, as in roofs, floors, &c., with the view of rendering them fire-proof; and many ornamental parts are found to be made economically of cast iron. For the manufacture of iron, see "Materials for Furniture."

SUBSECT. 12.—*Coverings for Roofs.*

151. *Various materials are employed to cover the roofs* in different parts of the world, according to climate and the natural materials; but in this country they are limited to the metals, slates, tiles, and thatch. Of metals, lead is the best, requiring no repairs for a long series of years; but it is heavy and expensive, and therefore entire roofs of lead are used only in churches and other public or valuable buildings, or where the roof is required to be flat. Lead is, however, partially employed in the roofs of all private houses. Sheet lead for this purpose is of two kinds, *cast* and *milled* lead. Cast lead is made by suffering the melted metal to run out of a box through a long horizontal slit upon a table prepared for the purpose. The thickness of cast sheet-lead varies from six to ten pounds in the superficial foot; seven pounds to the superficial foot is the most common. Milled lead is produced by passing the solid metal between steel rollers, and is made of various thicknesses, from three to five pounds to the foot; this thickness is not proper for flats nor gutters, but is used for hips, ridges, flashings, &c. Some, however, prefer stout milled lead to cast, as not being so liable to have the defects called *pinholes*, which cause leakages difficult to discover.

Zinc is of late occasionally used to cover roofs, being lighter and cheaper than lead; but it is not so much to be depended upon, oxidating in many cases, to which lead is scarcely at all liable.

Copper is likewise employed as roofing (see farther, "Materials for Furniture"), where the want of pliability hinders the use of the other metals, or where great lightness is an object; but this metal is now almost superseded by the use of zinc.

Slate is by far the most general covering for the roofs of good houses in Britain. When of the best kind, it is light and durable. The slates employed are chiefly of two kinds; one large and rather heavy, quarried chiefly in Westmoreland, and used only in large edifices where the walls are sufficiently strong to support the weight, and where durability, and not cheapness, is the principal object. The other kind, smaller and thinner, come principally from North Wales. The first is of a light greenish gray colour, the

other a dark or bluish gray. Of Welsh slates there are different sizes, called *Welsh rags*, *imperials*, *duchesses*, and *ladies*. Excellent slates are found in the western isles of Scotland, as the Eisedale slates, used in Edinburgh.

152. *To try the goodness of slates*, lay one in an oven till perfectly dry; weigh it, and then immerse it in water for some time. When taken out, wipe it carefully with a dry cloth, and weigh it again. Those slates which have acquired the least additional weight, and consequently have absorbed least water from being the least porous, are the fittest for roofing. Good slates should be thin, dense, and of a smooth surface. Balance one on the finger, and strike it with a hammer; if the sound is clear, the slate may be considered as firm; if dull, the slate is less dense, and should be rejected.

153. *Before the slates are put on*, the rafters are covered with boarding, and on this the slates are fastened with nails, being laid over each other, so that the water falling on any joint, instead of reaching the boarding, falls on another slate beneath, there being, in fact, a double thickness of slates.

Slating should be pointed on the inside, or plastered with a coat of lime and hair, to keep out the wind and snow effectually: this keeps the ceilings dry and the house warm.

154. *Patent slating* is done by laying large slates side by side on the rafters, without boarding, and cementing, and screwing fillets of slates over the joints. This kind of slating may be laid with a pitch of only ten degrees; whereas ordinary slating requires at least twenty-five degrees. It is little used, the cement being apt to decay.

155. *The rain water is carried away from the roof* in several modes. The simplest and most ancient mode, which is still practised, is by *dripping eaves*; but these, in the old manner, had the great inconvenience of keeping the wall wet, besides the annoyance to persons walking near. When the eaves project considerably, in the manner of Italian buildings (a mode that is frequently imitated here in small houses), the appearance is picturesque from the deep shadow thrown on the wall; and the disagreeable effect of the water dropping is obviated by placing a small leaden trough, as at *a*, *fig*. 41, at the extremity, to catch the water before it drops; from this the water is led into a perpendicular pipe; or, for very small roofs, a semicircular lead trough may be placed, as at *b*. But for large houses, and for all those in the streets, the construction of gutters and parapets is used, by which the rain and snow water is let down by a pipe into the street drain. Great attention must be paid to these gutters on the roof, not only with regard to their first construction, but that they are always kept in proper repair; otherwise, if they are improperly formed or neglected, the water will penetrate into the houses, and injure the apartments, an accident to which eaves are not so liable. It may be proper to notice a few circumstances on this subject. All lead gutters must have a small degree of slope to give the water a current, which, particularly in those of considerable length, increases the width of the gutter at one end, and therefore demands a greater quantity of lead. Speculators, to avoid expense, are apt to make this slope too small. The sheets ought never to be joined by solder, because, if confined, the expansion in warm weather would cause the lead to crack; but they are connected by drips, a kind of step of two inches, made in laying the boards for the lead. The lead over this is only hammered close, as in the black line, *a*, *fig*. 42, and not soldered. For the same reason of saving lead, builders sometimes make this step too little; and when this is the case, the snow, in thawing, is liable to rise up in this joint, and to damage the ceilings. The lead of the gutter is also made to pass for seven or eight inches up under the slates *d d*, to keep out the wet, as is shown by the dark line at *b c*; and when the lead is not cut wide enough to admit of this, the snow water, in heavy falls, will also gain entrance under the slates. At the other edge the lead of the gutter turns up against the parapet, as at *b*; and a slip of lead called a *flashing*, as *f*, is let into the brickwork, and turns down over the lead of the gutter, to prevent the rain insinuating itself between it and the brickwork. When wet appears in the ceiling of the upper story, it is frequently owing to some of these circumstances having been neglected; or, perhaps, from some crack in the lead. The whole should therefore be carefully examined by the plumber; but if the defect arises from the lead of the gutter having been originally cut too narrow, there is no effectual remedy but taking it up and putting down wider lead—an operation both tedious and expensive. It

Fig. 42.

must be evident, therefore, that, in a new building, these points demand particular attention. We may here observe that, in very heavy falls of snow, the wet will sometimes rise under the slates, even when the lead is of the proper width, if the precaution be neglected of throwing off the snow before it thaws. The *ridge* of the slates is likewise covered with a slip of lead, as also the angles of the roofs, called *hips* and *valleys*.

When the whole of the roof is covered with lead, or in flats, as the sheets must not be soldered together, they are joined by the edges being hammered round a semicircular piece of wood, *b*, *fig.* 42, in the manner shown by the dark lines, *a*.

156. *Tiles* form a heavier covering for a roof than slates, and are now only employed for offices and houses of an inferior class. There are two kinds of tiles in common use, *plain tiles* and *pantiles*. Plain tiles are of the same form as slates, but are laid on laths of oak or fir, and bedded and pointed with mortar. The pitch of the roof requires to be 45 degrees, and the tiles require frequent pointing. Pantiles are curved, as in *fig.* 43, and are laid on each other dry: they are seldom used except in cowhouses, sheds, and other out-buildings. They do not form so warm a roof as plain tiles, and are more liable to be deranged.

Fig. 43.

157. *Tiles, in the form of antique tiles, fig.* 44, are employed at present by the Italians. They are picturesque, and are suited to low-pitched roofs. *a* represents one of the tiles, having the edge turned up: two of these, being laid together, the turned-up edges are covered by a semi-cylindrical tile, *b*, bedded in cement. These last are made a little tapering upward, to fit on each other. *c* represents the appearance of the tiles when put together. Tiles of this form are also made occasionally in some parts of England.

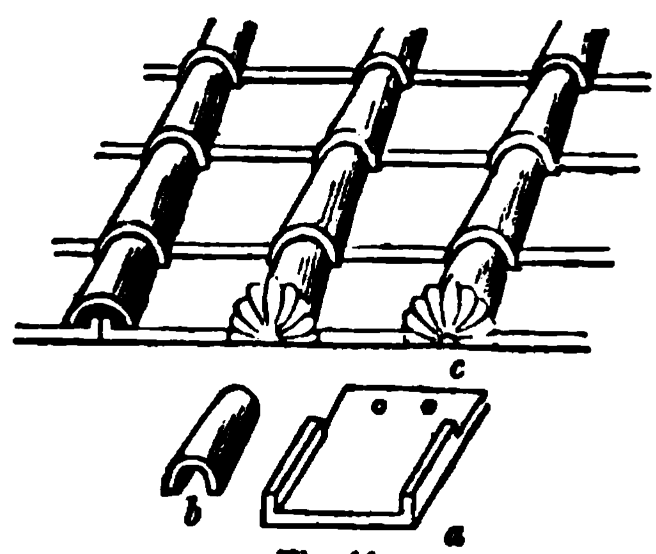


Fig. 44

Common tiles are not nearly so durable as slates, being much affected by the frost: but when glazed, as they sometimes are, with a dark glaze, they are very durable.

When the red colour of tiles is objectionable, they may be covered with a coat of anticorrosive paint.

In ornamental cottages, a thatched roof often forms part of their character. Thatch is cool in summer and warm in winter; but the objections to it are, danger from fire, and want of durability: it is also liable to harbour insects when it grows old. For temporary constructions, painted canvass may be used, or even paper pitched and sanded. Boards or shingles may likewise be employed.

SECT. II.—DETAILS OF FINISHING THE INTERIOR.

158. *Having now completed the skeleton or carcass of the house*, it is necessary that it should remain some time after it is built, before proceeding to finish it, not only that it may become thoroughly dry, but that the walls should settle in every part. There are few ordinary buildings where some slight settlements do not occur in the foundations from the unequal pressure of the parts; sometimes these may not be of the smallest consequence, as they soon stop entirely: but should the finishing be proceeded with in too great haste, and before the carcass is completely settled and dry, the various internal works, if ever so well executed, may be injured, and appear as if they had been badly executed. Gentlemen are often impatient to have their house finished; but it is proper they should be acquainted with the risk that they run by insisting on too rapid a completion.

159. *The finishing comprehends all the details of work, both within and without*, independent of the bare walls, and timbers of the floor, partitions, and roof: it is executed by the joiner, plasterer, painter, glazier, paper-hanger, plumber, smith, and ironmonger. Of these the principal is the joiner, who lays down the flooring-boards, puts up the staircase, makes the doors, sashes, window-shutters, and, in short, all the mouldings and finishings of wood throughout the house, together with such parts of the furniture as are called fixtures; he also sometimes supplies verandas and window-blinds: the greatest part of the joiner's work is prepared in the shop, ready to put up. The plasterer coats the walls with plaster and stucco, and puts up the ceilings, cornices, and other plaster ornaments. The house-painter paints the outside and inside work; the glazier fills the sashes with glass; the paper-hanger covers the walls of apartments with paper; and the plumber supplies the water-closets, and puts up the necessary lead pipes and cisterns.

The style of finishing must, like that of the exterior, depend upon various circumstances, such as the expense to be incurred, and the condition and rank of the proprietor. With regard to the expense, much care should be bestowed upon choosing the mode in which the various works are to be executed, and the decorations to be introduced; in

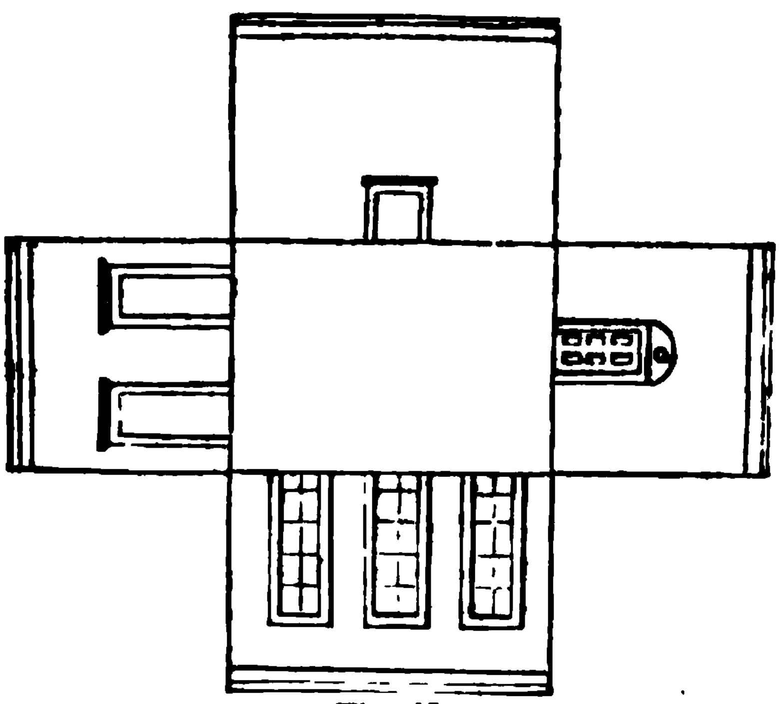


Fig. 45.

these, not unfrequently, much useless expenditure is occasioned, without corresponding advantage. In the modern style of finishing our apartments it must be admitted that vast improvements have been made of late. The use of oil paint, and the invention of paper-hanging, have given a lightness and airiness to our apartments, strongly contrasted with the heavy effect of the dark-coloured wainscot and dust-collecting tapestry of former times; while the abundant introduction of light, by means of large panes of glass, adds a cheerfulness formerly unknown.

160. *The finishing of all the apartments may be designed and exhibited* previously to execution, by drawings made in the manner shown in *fig.* 45, where the four sides are laid down round the plan. On each of these the several details may be inserted; and even the window-curtains and furniture may be shown.

SUBSECT. 1.—*Plastering the Walls and Ceilings.*

161. *The business of the plasterer* commences as soon as the brickwork is thoroughly dry, and not before, otherwise there will be danger of the drying and finishing of the house being protracted, as we have stated. The name of this trade is derived from *plaster of Paris*, the substance of which all plaster ornaments and cornices are made, and which is sometimes employed, likewise, to mix with mortar for the plastering on walls to cause it to set sooner. It is produced from a stone or mineral, called gypsum, in the following manner: The gypsum is broken into small lumps, and submitted to the action of a heated oven. When cold, it is ground to a fine powder in a mill, and is then fit for use. A paste made of plaster of Paris and water, of the consistence of thick cream, has the peculiar property of setting, or becoming solid, in a few minutes; and upon this property depends the method of making plaster-casts. The moulds for these casts having been previously oiled, the liquid mixture is poured into them, and when it is hard the casts are taken out. This material is so called from its having been originally imported from Paris, where it is made plentifully from the gypsum of Montmartre; but what we now have is prepared from gypsum found in Derbyshire and other places; this is brought to London, where it is calcined, ground, and sold in brown paper bags. But the business of the plasterer is not confined to plaster-casts; he likewise lays on the coatings of mortar to walls, partitions, and other places; and he also does the stucco, whitewashing, and some kinds of colouring.

162. *Brick walls to be plastered* ought first to be perfectly dry; and the process of covering them with plaster is termed *rendering*. The first coat laid on consists of good common mortar, having hair from the tanyards mixed with it, to prevent its cracking. The second coat, called *setting*, is done by a finer mortar, made with lime and fine sand. The lime used in this case is called *fine stuff*, and is prepared by slacking quicklime with very little water, and afterward saturating it with water to excess, putting it into tubs to settle and cause the water to evaporate; by this means a fine material is procured: a nicer kind of it is called *putty*. The use of the second coat of plaster is to give a perfectly smooth surface for colouring or papering. Sometimes, if the work is required to dry or set very soon, a little plaster of Paris is mixed with it, and it is then called *gauged stuff*.

163. *In order to secure the perfect dryness of plastering or stucco in good apartments*, the brick walls are generally *battened*. This is fixing on them long upright slips of wood called battens, on which laths are nailed close together horizontally, thus leaving a cavity between the laths and the walls. The plastering being laid upon these laths, no wet that may penetrate the wall can reach the plaster: this kind of work is termed *lath and plaster*. The first coat laid on consists of lime, sand, and hair, which is termed by the plasterer *pricking up*. The next coat is of a finer material, and being laid on and smoothed with a flat tool of wood called a float, is termed *floating*. The setting, or third coat, is done with fine stuff, to which is sometimes added a little plaster of Paris, to make it dry quicker and be firmer for the paper. The lath and plaster for partitions of quartering, likewise for ceilings, is done in the same manner. It is to be observed that, previously to the plasterer beginning to lay his several coats of plaster on walls, the joiner must fix his *grounds*, which are pieces of wood nailed to the bond timber and wood bricks, projecting as far from the wall as the finishing of the plastering; and to these grounds he afterward nails his skirtings, architrave mouldings of doors, windows, &c.

164. *Stucco for inside walls or partitions* is composed of fine stuff with fine washed sand,

in the proportion of one part of the latter to three of the former; and sometimes, if it is required to dry in a short time, it is *gauged*, by mixing a little plaster of Paris. The best stucco for apartments and staircases is laid on a floated ground, and is worked very even with a large trowel, till it is as smooth as glass; if the stucco is not perfectly flat, the irregularities will appear where it is painted in oil: this is called *trowelled stucco*, and is the fittest for painting upon.

165. *Cornices, if they are large*, are first begun by fixing wooden brackets in the angles, and covering those with laths, which receive a coat of common plastering; afterward the mouldings are run in a fine mortar by a mould made of a piece of wood cut out to the profile of the drawing given; and they are finished by fine stuff. When there are ornaments in the cornices, they are cast in plaster of Paris, in short lengths, and fixed up by the plasterer in the places allotted for them. The modelling of these ornaments in the first instance, from drawings made by the architect, requires to be done by persons of great skill and practice, who have devoted themselves to this branch of art.

166. *Ceilings were, some years ago, very much enriched with paintings and ornaments in plaster;* but much labour appears to have been thrown away in this practice, as it is painful to look up at such ceilings. There is now seldom more done than to put a large flower in the centre to hang the lustre or lamps from; and this flower is best made of papier-machée: between the leaves of this ornament there may be apertures for ventilation. Cornices are likewise much reduced from what they were in old houses; and friezes below them are, in general, totally omitted: all which adds much to the apparent height and lightness of the apartment.

167. *Whitewashing, or colouring, is the last operation on ceilings*, and this is sometimes used in other places. Whitewashing is done with whiting made from chalk. Balls of whiting are broken in water; and this is best done over night. To take off from the glare of the white, a little blue-black is sometimes added for ceilings. A quantity of warm dissolved size is put to this, and the whole is well stirred in a pail. The whitewashing is laid on with a large flat brush. When old ceilings are whitewashed, it is difficult sometimes to hide the stains; the best way is first to wash and scrape off with a trowel the old whiting and dirt, the surface being wetted with a flat brush, and to stop up all the cracks and defective places in the old work. In cornices, some pains is necessary in scraping out the leaves and ornaments. The ceiling must dry thoroughly after this operation before the whiting is attempted. If no size can be had, a little carpenter's glue, boiled to the consistence of size, will serve as a substitute; or potato starch will answer.

SUBSECT. 2.—*Floors.*

168. *The flooring boards* are never put down till the carcass and roof are quite finished, and the temporary windows put up to keep out the weather; but the boards are sawn, rough-planed, and set up to dry and season thoroughly, which generally requires a year. Oak was formerly used for the best floors, and was often laid in curious patterns, called *marquetry;* but this is now out of fashion in this country, the universal use of carpets having superseded it, and, indeed, rendered the appearance only of the boards of less consequence, regard being had chiefly to the floor being perfectly level and tight, on which account it is essential that the boards do not warp or shrink after they are put down, either of which circumstances proves injurious to the carpets. The best wood in general use is yellow deal; white deal is softer, and does not wear so well. It is also required in the best floors that they shall be of clean deal, that is, without knots, sap, or other blemishes. The boards are laid down and put together in various ways, according to the kind of apartments and the expense to be incurred. In the commonest rooms they are simply nailed to the joists; but in better apartments, to prevent water from passing through to destroy the ceilings of the rooms below, they are *rebated*, that is, the edge of one board is ploughed with a groove, into which the rebate of the next board is inserted. See *fig.* 46. When the boards are not all of one width, and are laid down in a particular manner several at a time, the floor is called *folded:* this is only practised in the cheapest and commonest floors. When the joints of the boards are all continuous, the boards being all of the same width, the floor is *straight joint;* of this kind are all the best floors, in which the boards are secured in such a manner that the heads of the nails are not seen: the boards are then fixed down by means of *dowells* or pegs on one edge of the boards going into holes in the opposite edge, while these edges are fixed to the joists by having the nails driven in slantwise. The whole of the floor can then be planed off together.

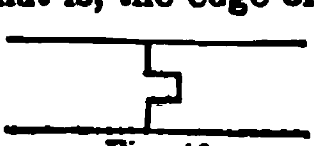


Fig. 46.

169. *In marquetry*, or *parquetry*, an ornamental kind of wood flooring, small pieces of wood of various kinds were cut in certain patterns, and fixed down upon the flooring-boards: the shape of the pieces was seldom more than rectangular, laid in various ways; and the wood was usually oak. It was a kind of mosaic in wood. Specimens of it may still be seen in ancient mansions.

170. *Mosaic, or tesselated pavements*, are not frequently executed among us in ordinary houses, though they were much in fashion among the Romans; beautiful examples of

them have been dug up in the ruins of their villas: tesselated pavements were likewise executed in Gothic buildings in this country some centuries ago. Our custom of covering all our floors with carpets or mats renders these not very necessary. The pavements of halls are sometimes decorated with black and white marble, being laid in squares, or octagons; but, in general, Portland or other stones capable of being worked smooth are sufficient.

171. *Tesseræ for pavements* are now made by several manufacturers, and they appear to be coming into fashion in public buildings and large mansions. Messrs. Chamberlain and Co. of the porcelain works, Worcester, make strong earthenware tiles, either plain red, yellow, or decorated with various coloured patterns in imitation of old English tiles, specimens of which remain in Westminster Abbey and other ancient Gothic buildings Some are now executing for the new Houses of Parliament. They are generally glazed but may be had also unglazed. Tesseræ for mosaic pavements of a variety of patterns, both antique and old English, are likewise manufactured by Wyatt and Parker. Another variety is made by Singer, of Vauxhall, and has been used in the Reform Club-house.

172. *Floors are likewise formed with bricks and tiles.* Brick paving is done either with the bricks flat or on edge, and laid in sand, or in mortar. Brick on edge paving in sand is usually laid in beer and coal cellars, pantries, dairies, or stables, as the open joints allow the fluids to sink through and escape. Bricks laid in mortar make a sound paving; a paving of tiles is neater, but not so durable as one of brick on edge. These kinds of paving are frequently used in farmhouses and cottages: floors in such places are likewise made of various cements.

Subsect. 3.—*Staircase.*

173. *When the staircase is of stone,* Portland stone is the material most commonly used in London: where Bath stone is plentiful, it is sometimes used, but it is too soft. When wood is used, oak is preferable, and was formerly much employed; but in good ordinary houses, yellow deal suffices, as the stairs are generally carpeted. Putting up a staircase well, and particularly the handrail, is one of the most difficult parts of the joiner's business, and the most skilful hands are required for it. The size of the steps is calculated by the architect, who has to consider the height of the stories, and the space in his ground plan; but he cannot depart much from the customary height and tread of steps.

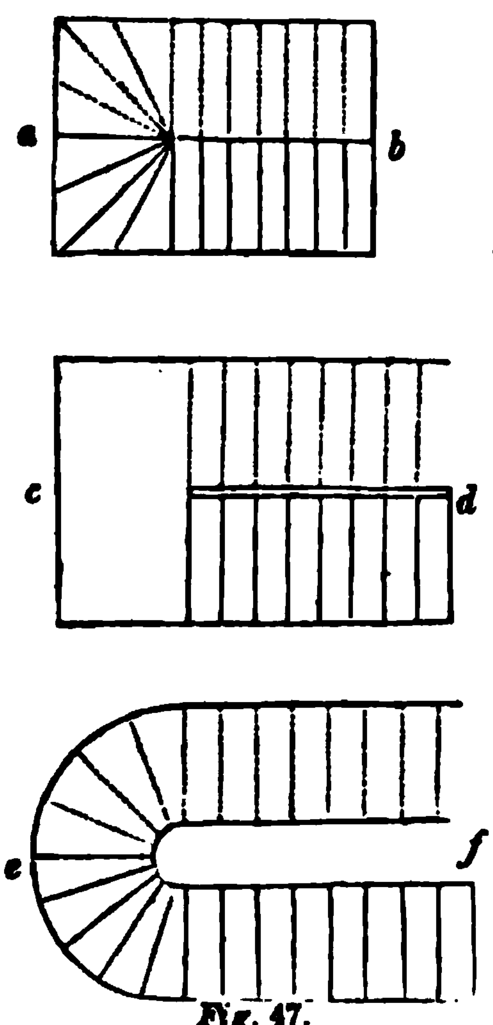


Fig. 47.

174. *A dog-legged staircase* is one where there is no well hole, *a*, *b*, *fig.* 47, and the return of the stair is effected by *winders* fixed to a *newel.* This kind of stair is inconvenient, the width of the steps being diminished to nothing close to the newel: it is, of course, limited to inferior houses, attic stories, &c. In the *better kind of staircases* there are landings at half the height of the story, *c d;* and in plans it is customary to mark the commencement of the flight-steps with lines, while the last half is shown by dotted lines. A *geometrical staircase*, *e f*, is one where the steps wind round an open newel, or, as it is called, a *well* from top to bottom. This is used in cases where the light to the staircase is admitted only from a skylight. These may be circular or elliptical on the plan. The staircase is a very important part of a house; it should be conveniently situated, well lighted, and of easy ascent.

Subsect. 4.—*Doors.*

175. *If the doors are not made of wood well seasoned,* and executed in a workmanlike manner, they will shrink after the painting is finished, and look very ill. The locks, which are of various kinds, and other fastenings, are parts of furniture that demand great attention. To enable doors to rise over the carpets, and yet be tight at the bottom when the door is shut, rising hinges are sometimes used, and are extremely serviceable, cold draughts just over the carpets being very unpleasant and injurious, though frequently unattended to. There are various other inventions for this purpose. In laying the flooring-boards, it is usually the practice to make the floor rise gradually about a quarter of an inch under the door.

The doors of apartments are always framed in two, four, or six panels, which are either plain and square, or ornamented with mouldings. Those of ordinary rooms are of deal; but in the best apartments of large houses they are frequently of mahogany.

Subsect. 5.—*Windows.*

176. *Upon the judicious construction of the windows much of the comfort of a house depends:*

bad sashes are a continual nuisance, letting in draughts of cold air, rattling, or re frequent repair. The sashes of the present day, hung with weights and pulleys great improvement on the ancient casements with hinges: when well made, and materials, they answer very well; they should always be double hung, that is, t bottom sash moveable, on account of ventilation. Wainscot is the best kind of w sashes, being the most durable, and least liable to shrink. Mahogany is sometim ployed in the best houses. Sash fastenings should never be omitted, for the pur binding the sashes together to keep out the cold, as well as for security. Cheap ill made, are far from being economical. French sashes that come down to th and open with hinges, are pleasant in drawing-rooms, or apartments that comm directly with a lawn or garden, but they are apt to be cold in winter. *Double* sas two sashes a little way apart, little used here, but universal in Russia, are ext warm, and have the good quality of excluding noise, properties which render the suitable for certain situations. It is to be observed that more light comes from th than from the lower part of a window, and therefore, where much light is requir sashes should reach as high as possible; in low apartments the light is often obs by useless drapery of window curtains.

177. *By the Building Act*, all door and window frames are to be set in newels cesses, at least four inches from the front of the building, as a security agai spreading of fires.

No bow-window or other projection shall be built next to any public street, so extend beyond the general line of the fronts of the houses in the said street, excep projections as are necessary for copings, cornices, facias, door and window dressi for open porticoes, steps, or iron pallisades; and also, except shop windows, whi allowed, in streets thirty feet wide or more, to project ten inches from the line building, and five inches in streets of less width.

178. When the sashes have been completely finished by the joiner, and painted painter, they are filled in with glass by the glazier, who secures the panes by me putty made of whiting and linseed oil.

179. *Window shutters* are framed in the manner of doors, and are made to fold eral widths by means of hinges to go back into a recess at the sides of the wi When the walls are too thin to receive the necessary width of the front shutte architrave is brought forward in the room, or the shutters are made to slide up and

180. *For the manufacture of glass*, see the article "Glass," in Book V., "Furni

181. *There are several kinds of glass in common use for windows.*—plate glass, glass, and common glass. Plate glass is by far the best, though most expensive, all distorting the objects viewed through it, which is more or less the case with al kinds of glass. It is often introduced into the windows of the best kind, as also i of shop fronts. Crown glass is always used in the best windows in ordinary l There were formerly two kinds of glass made in London, Ratcliffe crown and La crown, but from the greater price of fuel in the metropolis, the glasshouses are r moved to Newcastle and Bristol. Window glass being all blown in circular plat exceeding five feet in diameter, these are cut by the glazier's diamond into panes ous sizes, from the part surrounding the knot in the centre of the plate. Panes procured 33 inches by 25. Glaziers describe panes of glass as firsts, seconds, and The *firsts* are crown glass, the *seconds* and *thirds* are common and inferior glas thirds being of a greenish tint, and used only in very ordinary situations. Panes are charged more per foot as they increase in size, because there is more waste large panes are cut from the circular tables than where the panes are small.

182. *When light alone is required for offices* where it is not convenient to see t the glass, ground glass, or wavy or granulous glass, is used: to imitate the form nomically, the effect may be produced very nearly by dexterously applying a l glazier's putty, or even thin size and whiting, or boiled starch.

SUBSECT. 6.—*Chimney-pieces.*

183. *Chimney-pieces are decorations surrounding the openings of chimney fireplac* the principal apartments they are usually ornamented more or less with sculptu they form a principal feature in English houses. Rules have been sometimes gi writers on architecture for proportioning the size of the openings of chimneys to t of the apartments; but such rules are not founded upon any principle that can mitted. The use of the fireplace is to warm the apartment, and as the mode of plishing this effect has varied through improvements in the nature of the fuel, a way of using it, so the size of the chimney opening has been subject to change, decorations surrounding this opening have been modified accordingly.

In the time of Queen Elizabeth, when wood was the fuel, the chimney-openi large, and the chimney-piece reached nearly to the top of the room. In after times coal became the fuel, and Grecian architecture came into fashion, the size of th ney opening was reduced, and the chimney-piece partook of the general style apartment; but for a long time the mouldings and ornaments were of a massiv

About fifty years ago the modern French taste began to be imitated here, and great elegance has been attempted in the design and execution of chimney-pieces suited to our improved fire-grates. In consequence of Count Rumford's principle of lowering the fire itself, the cornice of the chim ey-pieces have descended to a convenient height for placing ornaments upon them. In the best apartments chimney-pieces are always of marble, either white or coloured, the first being the most usual in the drawing-room, and the latter in libraries and dining-rooms. Those in inferior apartments and offices are of various materials, as Portland stone, slate, or even wood, which may be painted and sanded: cast iron is likewise sometimes employed. Chimney-pieces of all kinds may be economically purchased, ready made, at the show-rooms of stone masons and sculptors, but in the best houses they are generally designed by the architects.

Subsect. 7.—*House Painting*.

House painting is practised, not only for decoration, but likewise for the preservation of the woodwork.

184. *The application of oil painting to our houses* is a very great improvement upon the practice of our ancestors, and has come into general use only since about the beginning of the last century. Before that time the woodwork, both within and without, was uncovered with paint; and we still see the effect of this in very old houses. Oak acquired a very dark sombre colour; and when deal was first introduced, it not being the practice to paint it, the effect was worse, as it contracted dirt, without admitting of being so easily cleaned by polishing and brushing as oak. Oil paint not only preserves woodwork from decay, but has the advantage of being easily cleaned by soap and water; and when at last that fails, the painting may be renewed at a small expense, thus preserving a perpetual freshness in our apartments, conducive at once to health and cheerfulness. The practice of house painting has given rise to a taste for cleanliness and elegance in our dwellings that could not otherwise have been so well attained.

185. *There are various kinds of painting*, according to the nature of the vehicles employed for the colours: as oil painting, distemper, and fresco.

186. *Oil painting* being the most important as applied to our domestic buildings, we shall commence by describing it; and first of its materials.

187. *White-lead* forms the basis of this kind of paint, to which are added a certain quantity of various pigments when different tints of colour are required.

188. *White-lead is made in the following manner*. Sheets of lead are rolled up spirally, so as to leave the space of about an inch between each coil, and then are placed vertically in earthen pots, with a ledge in them to support the lead. In the bottom of each pot is some good malt vinegar, or pyroligneous acid. The pots are then covered, and placed in a bed of horse dung, or of tanner's bark. The vapour of the vinegar oxydizes the surface of the lead, and converts the oxyde into the diacetate of lead; while the carbonic acid, which is extricated in consequence of the fermentation of the dung, rapidly decomposes this diacetate, and converts it into a *carbonate* of lead, which appears as a white crust upon the surface of the sheets of lead. The finest part of this comes off in flakes, forming what is called *flake white*, which is the best of the lead, and is employed only in painting oil pictures: this is collected, ground in water, made into lumps, and dried by stoves. The plates are thus treated repeatedly, till they are corroded quite through, and all reduced to the state of carbonate.

It is necessary to observe, that in the method just mentioned, of placing the lead in pots, the white-lead causes the sheets to adhere so firmly to the pots, that the workmen are obliged, in order to detach them, to knock, which occasions a great deal of dirt, extremely prejudicial to their health. By an improved mode, the rolls of lead are placed on a floor of boards pierced full of holes, and below this floor the pots full of vinegar are placed, sunk in dung, the vapour of the vinegar and the carbonic acid ascending to the lead through the holes: this method is not only more productive of white-lead, but there is no breakage of the pots, and the rolls being well sprinkled with water, the dust is avoided.

The white-lead, after the flake white has been separated, is scraped off, and then ground in water, and afterward saturated with linseed oil. It is then put into firkins, each containing about three hundred weight, in which state it is dispensed at the colour shops.

White-lead, when sold by retail, is frequently found adulterated with powdered chalk and various white mineral bodies, that very much injure its quality, causing it to have less body, and likewise to turn yellow when made into paint. As much of the durability and beauty of the paint depends upon the goodness of the white employed as the basis, especial care should be taken to have this genuine. When a large quantity is wanted, it is safest to purchase it at the white-lead works where it is made; but even there it is sometimes not free from adulteration. It is improved by keeping.

Adulteration with chalk may be detected by dissolving a little diluted hydrochloric acid, filtering it, and adding a little oxalate of ammonia. If chalk be in the white-lead, a cloudy white precipitate of oxalate of lime will appear, which is owing to the affinity of the oxalic acid for lime, the basis of chalk.

Nottingham white is a superior kind of white-lead, used in the best work in the finishing called *Flatting*.

189. *The oils employed* are those varieties which have a drying quality, which is increased by art: such as linseed oil, nut oil, poppy oil, lamp oil, and walnut oil. They are all obtained by pressure from the seeds of the plants after which they are named, and from the manner in which they are procured, they at first always contain mucilage.

190. *Linseed oil* is the only one that is employed in the large way in house painting: it is obtained by pressure from the seed of flax; and it is afterward filtered, to clear it of any of the husks of the seed, and then suffered to remain in tubs to precipitate and clarify. The freer from colour the oil is, the better; and its clearness is greatly improved by keeping: if kept for a year or two, it will deposite all its colouring particles, and be nearly as transparent as water. In this state the oil is called *raw linseed oil;* and though it has of itself a drying property, yet paint made with it would be very long in drying, and therefore means are employed to increase this property.

191. *Oils are rendered drying* by boiling them either alone, or with metallic oxydes; as litharge, ceruse, red-lead, &c. The mucilage is supposed to unite with the oxygen of the oxyde, and the oil itself is then ready to attract oxygen from the atmosphere, and to become solid. There are various methods of preparing drying oil. Add to half a gallon of raw linseed oil six ounces of litharge, and an ounce and a half of white vitriol. Boil the oil on these over a gentle fire, taking care to skim it from time to time: the matter which rises to the top, and which is skimmed off, is called by the painters *smudge*, or *dryer;* it is of a lead colour, and is used for outside work, and sometimes mixed in the dark colours, to make them dry quicker. When no more scum rises, the fire is stopped, the oil, being left at rest, gradually settles and clarifies. Linseed oil so prepared is sold at all colour-shops under the name of *boiled oil*. Instead of litharge, red-lead or white-lead may be used, or linseed oil may be rendered drying without boiling by mixing one pound of white-lead with a gallon of oil, and letting it stand a week or two, till the lead and the feculent parts of the oil have subsided. Some consider that the best way is to boil the oil simply for a considerable time, without any addition.

In boiling oil it is necessary to be extremely careful to prevent any water from coming into it while boiling; for a single drop would be instantly converted into steam by the excessive heat of the boiling oil (600 degrees), which, by its expansive power, would force part of the oil over the sides of the boiler; and this, taking fire, might occasion serious accidents.

192. Oil of turpentine, generally called *turps* by house painters, and improperly termed "spirits" of turpentine, is much in use as an ingredient in paint; and as its history is connected with several other substances employed, we will give them all together.

193. *Common turpentine* is the natural resinous juice which exists in trees of the fir tribe, and may be often observed exuding from a deal board which is exposed to the sun, particularly in places where there are knots, which abound in it. It is about the consistence of honey, of a yellowish colour, and is obtained in large quantities from the wild pine or Scotch fir (*Pinus Sylvestris*), but is brought to us chiefly from the northern countries of Europe. To procure the turpentine, the trees are stripped of their outer bark in the month of May for about six inches, so as to expose the inner smooth bark, near the foot of the tree, where an incision is made three inches square, and an inch deep. The resinous juice soon begins to exude in transparent drops, which fall into a proper receptacle. The turpentine continues to flow till September; and a healthy tree may yield from six to twelve pounds annually, and that for a century. This turpentine consists of common resin and essential oil of turpentine, which may be separated from each other by distillation.

194. *Oil of turpentine* is the essential oil, obtained by distilling with water the common turpentine just mentioned. This is put into a still with water, and, when heat is applied, the oil of turpentine comes over with the steam, being found in the receiver swimming upon the condensed water, from which it is easily separated. About 60 lbs. of the oil is procured from 250 lbs. of good turpentine. This process is carried on both abroad and at home; but the oil drawn in this country is always preferred. The oil of turpentine is used by the painter to mix with his oil colour to assist in drying; and it has an advantage over drying oil, that it is perfectly transparent and colourless. It has also another useful property, that of destroying the shining or gloss of common oil paint, as we shall describe.

195. *Common brown resin*, or rosin, called also colophony, is the solid substance that remains in the retort after the distillation of the oil of turpentine.

196. *Turpentine varnish.*—As the common turpentine drawn from the tree consists of essential oil of turpentine, having resin dissolved in it, it is evident that this essential oil is a solvent for resin. If resin be therefore put into oil of turpentine, it will be dissolved and constitute turpentine varnish, which may be made thin at pleasure by adding more of the essential oil. When laid on with the brush, the oil evaporates and leaves the resin as the varnish. Since resin is not soluble in water, turpentine varnish will resist

that fluid; and as it is soluble in oil of turpentine and in spirits of wine, it may be removed by either of these vehicles.

197. *Tar is an empyreumatic turpentine*, obtained by cutting to pieces trees of the pine or fir tribe, and exposing them to heat in a furnace or in the open air. In the latter mode the wood is cut into billets, piled up in stacks, and covered with turf. Fire is then applied to the wood, and it is suffered to burn with a slow smothered flame, during which process the tar is formed by the partial decomposition of the resinous juice, which flows to the bottom; the black colour is owing to the smoke and carbon or soot which is mixed with the product. The greater part of the tar used in England comes from the Baltic, and is made in the northern countries adjoining it, which abound in fir. In France and Switzerland tar is produced by a more economical process, and of better quality. It is there distilled from the wood in large brick ovens, and the charcoal which remains is used as fuel.

198. *Pitch* is tar of which the essential oil has been driven off by boiling. Tar differs from common turpentine in having been extracted by heat and blackened by the process, whereas the latter preserves its natural colour; but both contain the essential oil of turpentine, although this can only be obtained pure from the turpentine. Pitch is prepared in the countries where the tar is procured; and to convert tar into it, boiling is all that is necessary.

199. *The painter's tools are few.* The brush which they usually employ, called a *pound brush*, made of hogs' bristles, is first used as a duster, until the ends of the hair are so worn as to become soft; it is then better adapted to lay on the colour and spread it evenly; and the more it is used the better, till it begins to wear out. Smaller brushes are employed for the bars of sashes, called *sash-tools*; and a few still smaller are wanted for drawing lines, &c.

200. *Some of the colours are purchased* at the colour-shops in a prepared, and others in a crude, state. Some of the painters grind them themselves on slabs of porphyry or marble, with oil or water. It is of the greatest importance that all their colours, tools, and pots should be kept extremely clean and neat, and their brushes be kept moist and fit for use. When more colour is prepared than can be used immediately, it is prevented from drying by being covered with water.

201. *The first process in painting new work in oil* is to paint or cover by some mode the knots in the wood, to prevent the turpentine with which they are charged from coming through, as it would do after the work is finished. This is called *knotting*, which, in good work, requires to be done very effectually. The common method is to touch each knot with a brush full of paint made with white-lead ground in oil and some red-lead or litharge of lead as a more perfect dryer: some knots may require to be touched twice; but in the best work the most complete way is to touch the knots with gold size, and to apply gold or silver leaf to the knots, which effectually prevents them from appearing afterward when the painting is finished.

202. *The next process is priming the work*, or giving it the first coat, which generally consists of white-lead, with some red-lead to make it dry soon. The wood in this coat absorbs a good deal of colour; but it is important for the durability of the paint and the preservation of the wood, that the priming be executed carefully.

203. *The second coat of paint* is put on when this is dry, consisting of white-lead and oil, having an addition of a little oil of turpentine.

204. *Stopping* is the next process; but previously, the work should be smoothed over with pumice stone, to take down any little prominences or minute chips that become apparent when the paint comes on. Stopping is filling all the nailholes, cracks, and irregularities of any kind, so as to make the surface close and regular. This is done by a putty made of oil and whiting.

205. *The third coat*, which, in common work, is the last, consists of the same materials, if the colour is to be white; but as a perfect white is not always agreeable, nor likely to be durable, it is generally lowered, either by a little ivory or lamp black, if a silvery white be wished, or a little yellow ochre and burned umber, or some such colours, if a stone colour be required. This finishing coat should be laid on with peculiar care and in a workmanlike manner, not to show streaks or marks of the brush, nor leaving some places uncovered, while others are clogged with paint. In new work of the best kind, it is usual to give four coats of paint, particularly in outside work; but in this latter the use of turpentine is to be avoided, as rendering the paint more easily affected by water. If any other tint than white be intended, the second and third coats have the proposed colour made up, which demands good judgment, and a practised eye in the person who mixes up the colour.

206. *Oil colour executed in the manner just described will have a gloss* when finished and dry, resembling an imperfect varnish, which is no inconvenience, but rather an advantage, in ordinary places, as this kind of painting will bear to be cleaned with soap and water, without disturbing the paint; but in the best apartments this gloss has an unpleasant effect, and therefore it is destroyed by mixing a considerable quantity of oil of turpentine in the last or finishing coat, which occasions the paint to dry without gloss,

or be a *dead white*, or "flat," as it is called. This part of the process is accordingly termed *flatting*.

207. *The flatting is more difficult to do than any other coat*, and requires a more dexterous workman; for the turpentine evaporates so quickly that the work dries in a very short time, and the whole side of a room must be executed very quickly not to show marks of joining. More hands are, therefore, required if the work be large, or greater execution and despatch if small. From the quantity of vapour from the turpentine, this part of the process is often both troublesome and unhealthy to the men employed. Flatted painting, though more elegant and ornamental, does not admit of being cleaned or scoured so often as common paint, since the quantity of oil in the paint being small, the colour easily comes off: it will bear cleaning once, and perhaps, with care, twice or thrice; but common paint may be cleaned repeatedly, if done with judgment. Flatting is also much more expensive. Large surfaces sometimes require to be flatted twice, to render them complete. It is scarcely necessary to observe that each coat must be suffered to dry before another is laid on: but it may be too dry; and there is a point of time, which the painter knows, that is best suited to make the several coats adhere together firmly, and prevent scaling off.

It must be observed, that in all the above operations it is necessary to add some sort of dryer. A certain proportion of boiled oil is added to the raw, and sometimes a little sugar of lead ground in oil.

208. *Painting in oil on inside stucco* demands some farther precautions. It is absolutely necessary that not only the surface of the stucco should be quite dry, but likewise the walls upon which it is laid; otherwise, if there be the least dampness in the stucco, it is sure to cause the paint to scale off; and if the walls themselves be not dry before the stucco is put on, this also will frequently separate and come off in flakes. In general, in new houses, two or three years are not too long for the stucco to remain unpainted, though in houses got up on speculation, it is not unfrequent to allow scarcely as many months.

It is said to be best to lay on first a coat of linseed oil with proper dryers, that the stucco may absorb a sufficient quantity, and to follow this by three coats of oil paint, made up as before, allowing two or three days between each coat: at the third coat the ground colour may be laid on to receive the finishing colour, which is usually flatted. If it be necessary to make use of apartments before they are sufficiently dry to receive the oil colour properly, they may have a coat or two of distemper of any colour, which must be removed by washing, when the walls are to be painted in oil.

209. *The process of sanding* is frequently used to outside paint. This is dusting white sand on the last coat of paint to imitate stone; and, when done well, this has an excellent effect, and is durable.

210. *The most usual colours or pigments* employed in house-painting, to mix with the white-lead, are the following:

Reds.

Vermilion, a bright scarlet prepared from sulphur and quicksilver, being a sulphuret of mercury. *Red-lead* is lead calcined till it becomes a red oxyde. *Venetian red* is a native ochre. *Spanish brown*, also a native earth. *Lake* is alumina, the basis of alum, tinged with a dye from cochineal or Brazil wood: it differs much in quality. *Rose pink* is similar to the last, but inferior. *Red ochre* is produced by burning yellow ochre. *Burned Terra di Sienna*, the raw Sienna burned.

Blues.

Prussian blue is a preparation of Prussic acid and iron. *Blue verditure*, a colour from copper precipitated upon chalk. *Indigo*, a colour extracted from plants in India. *Smalt*, a glass coloured by cobalt, and ground to a fine powder.

Yellows.

Yellow ochre, called often stone ochre, a native earth of various qualities. *Dutch pink*, chalk coloured by French berries. *King's yellow*, arsenic combined with sulphur. *Naples yellow*, *Raw Terra di Sienna*, a native earth.

Greens.

Verdigris, a carbonate of copper. *Prussian green*, a composition similar to the blue of that name. *Terre verte*, a native earth.

Orange colour.

Orange lake, the tinging part of anatto or alumina.

Browns.

Burned umber, a native earth. *Asphaltum*, a native bitumen. *Bistre*, a kind of soot from peat smoke. *Cologne earth*, a native pigment dug up.

Blacks.

Lamp black, the soot of oil burned in lamps. *Ivory black*, ivory or bone burned to charcoal. *Blue black*, the charcoal of ivy twigs, or some other plants.

Whites.

Flake white, a superior ceruse. *White-lead*, carbonate of lead.

The above are all the colours usually employed by house-painters. We have omitted those which are only very seldom resorted to, or used in other branches of painting.

211. *Much judgment is required in making up the various tints used in house painting,* and adjusting them harmoniously to each other: our painters have of late years acquired considerable skill and taste in this part of their art; but it is impossible to give any useful verbal directions on this subject: experience and practice with those who are skilled are necessary, together with a good eye for colour. It may be sufficient here to mention the usual pigments employed in making up the tints that are most frequently employed. *Grey* is made with white-lead, Prussian blue, ivory black, and lake, or Venetian red. An inferior one with white, black, or Indigo, and Venetian red. *Pea* and *sea greens*, with white, Prussian blue, and yellow. *Olive green*, with white, Prussian blue, umber, and yellow ochre. *Fawn colour*, with burned terra Sienna, umber, and white.

Formerly it was the practice to finish much of the woodwork in white only; but this is now seldom done: some tint is preferred, as being less painful to the eye, and keeping its colour better.

212. *White paint preserves its colour best in pure air.* It is often remarked how much longer paint will keep white in the country than in town. This is partly owing to the smoke of the latter; but that is not the only cause, for the impurity of the atmosphere will change the colour of paint. Sulphuretted hydrogen is a very deleterious gas, composed of sulphur and hydrogen. (See VENTILATION.) Sulphur united to lead (or sulphuret of lead) is a substance of a blackish colour, with a metallic lustre; and when sulphuretted hydrogen is present where there is white-lead, the sulphur joins to the lead and forms a sulphuret. This deleterious gas, having the smell of rotten eggs, is generated where there are animal matters in a decaying state, and is abundant in the sewers, and places of that kind, where there are putrefying substances; consequently, white paint, in the vicinity of such places, is certain to turn very dark. This change of colour in paint may be more readily perceived in the basement stories of houses, and wherever there is any disengagement of foul air: it may, indeed, in some degree, be considered as a test of the purity of the air.

213. *Graining*, among house-painters, is understood to mean the imitation of the several different species of scarce woods used in articles of furniture; such as mahogany, satinwood, rosewood, kingwood, oak, &c. This kind of painting is now very generally practised, and frequently with great dexterity, some of these woods being so well imitated as scarcely to be distinguished from the originals. Some graining, as the imitations of rare and beautiful woods done in the best manner, is expensive; but graining like oak or wainscot is cheap, costing little more than flatting, and lasting very much longer. It is admirably adapted for doors, architraves, windows, sash bars, and other parts liable to become dirty; and in many rooms the whole of the woodwork is now grained in imitation of some wood or other.

214. *Marbling* is allied to graining, and both are generally performed, when in the best manner, by painters who confine themselves entirely to this branch of the trade. There is much skill and ingenuity shown in imitating the various marbles and porphyries by the study of good slabs of these materials; and when the selection of colours is judicious, the effect is certainly extremely rich, and much preferable to the quantity of cold white once almost universal in ordinary houses. But when the imitations of wood or marble are badly performed, the effect is, on the contrary, particularly disagreeable.

In rooms where there are many pictures hung up, the walls should be painted with a plain colour, as any printed paper injures the effect of pictures; and, in this case, the colour should be that which will suit the pictures best.

215. *The painting of ornaments* is a distinct branch of the business, and is practised only by persons who have learned to draw, and who devote themselves entirely to this art. The name of *Decorator* is now assumed by persons who either paint ornaments, or, more frequently, undertake to get them executed.

216. *When woodwork is to be repainted*, it should be first well dusted down and cleaned, stopping all the cracks and defects with putty; after which it should receive two coats of paint, either white or coloured, as may be required. Should any parts be greasy, the paint will not dry upon it, except the grease be first scoured off with pearlash, or turpentine be mixed with the paint: the first is the safest method.

217. *What is called clear-coat and finish* is a cheaper but less perfect mode of painting. First the cracks in the woodwork are stopped; then it is gone over with a coat of size only, with a little white-lead, which fills up the pores of the wood, and prevents its farther absorption; the next and last coat is of white-lead and oil, constituting the finish. This is a bad method, and altogether unfit for outside work, as the size prevents the perfect adhesion of the paint, causing it often to scale off. Dishonest painters, who undertake work by contract, sometimes practise this instead of painting in a proper manner, when they suppose their employers to be ignorant of the processes of painting; and it is sometimes not easy to detect the fraud when the work is finished. In some cases, however, this coat of size and white-lead is almost necessary, where old work to be repainted is so greasy and dirty as not to take the oil paint.

218. *House painters are liable to be affected by a disease* peculiar to them, called the *painters' colic*, which sometimes becomes fatal; and, if not removed in time, it often terminates in nervous apoplexies or palsy, first of the hands, then of the lower extremities, or depriving them of the use of their limbs. These diseases are owing to the white-lead, or carbonate of lead, of which they use so much. Dr. A. Thomson observes, in his "Materia Medica," that, when colic only is present, castor oil, combined with opium, are the best remedies; but if there is reason to suspect that a portion of the carbonate still is present in the stomach, sulphates of magnesia and soda should be administered: these salts convert the carbonate into a sulphate, which is inert, and is carried off by the remaining part of the salts. This author considers carbonate of lead as the only salt of lead that is directly poisonous, and that, with painters, the disease is frequently induced from want of cleanliness in not sufficiently washing their hands before taking their food. It acts, however, probably also upon the nerves of the skin. Of all the artisans who work in lead, the manufacturers of white-lead are the most in danger from the *colica pictorum*; and, before the present mode was adopted of grinding the white-lead under water, they suffered much from the dust of this material, which filled the air of the grinding-houses; but, since this improvement, very few cases of the disease occur.

219. *Painting in distemper* is mixing the colours up with size instead of oil as a vehicle. Some balls of fine whiting are laid to soak in water over night; and the size, rendered liquid by warming in a pipkin, is poured in, and well stirred up with the whiting. Some colours, finely ground, are added, according to the tints required. This kind of painting is much cheaper than oil-colour, and has no gloss whatever; but, though it looks extremely well if kept clean, it has the inconvenience of being easily stained; and, as it does not bear washing, any foul marks cannot be removed, neither can they be painted over, as the colour cannot be exactly matched again, and any attempt to touch them with paint would only increase the evil. It must be done upon very smooth and dry plastered walls, or upon papered walls. Woodwork is never painted in distemper, as it would not form a good preservative; nor can it be employed in outside work. It demands, like flatting, to be laid on with despatch and dexterity—not to be streaky and uneven. If possible, the whole side of a room should be covered before any one part has quite time to be dry; for this, sufficient colour should be mixed up, and a sufficient number of hands employed.

220. *Various tints in distemper may be made* as follows: *Straw colours*, with whiting, masticot, and Dutch pink; or with whiting, yellow ochre, and a little Venetian red. *Fawn colour*, whiting, Venetian red, and a little black or burned umber; or with white and burned Sienna. *Grass*, white and verditure, with Venetian red;, or with white, Venetian red, and Prussian blue. *Pea green*, with white and Olympian green; or with white, yellow ochre, Prussian blue, and raw umber. *Olive green*, with white, Prussian blue, and burned umber, and yellow ochre.

221. *Those who wish to paint in distemper* must practice mixing up the colours, which is more difficult than in oil, because the tints dry much lighter than they appear when wet. It is necessary, therefore, in order to ascertain what colour a certain mixture will produce, to paint a slip of paper over with it, and to dry it at the fire to see the tint: if this be neglected, the operator will be entirely deceived with respect to the colour of his painting. Nevertheless, it is so easily done, that any one possessed of a little ingenuity may paint over a small room; a circumstance worth knowing, where cleanliness with economy is a great object: and it has the advantage of giving little or no offensive smell during the operation, and for some time afterward, as oil paint does, but may be begun and finished in a day or two. Two coats are generally necessary to cover completely.

222. *When old plastering has become discoloured by stains*, and it is desired to have it painted in distemper, it is advisable to give the surface, when properly cleaned off and prepared, one coat at least of white-lead in oil, with some spirits of turpentine, which will generally fix all old stains that would otherwise come through; and, when quite dry, this will take the water-colours very kindly.

223. When we reflect upon the great importance of cleanliness in our dwellings, the value of painting, both in oil and in distemper, should appear striking. Many servants learn to whitewash very well; and sufficient knowledge of painting, both in oil and in distemper, may be easily acquired by those who are desirous of it: a circumstance which may be of great use to them some time or other in the course of their lives: not a few servants have gained their livelihood by practising painting as a trade.

224. *A very good substitute for size* can be prepared from potatoes. Make starch from the potatoes in the usual manner, mix the whiting and water to the proper consistence, and add the starch. This has the advantage of being wholly without smell, and is also beautifully white. It forms an excellent material for whitening ceilings. It may be observed that, as whiting is only washed chalk, the latter, pounded very fine, may be made shift with, when whiting cannot be procured.

225. *Milk Paint.* A paint has been used on the Continent with success made from *milk and lime*, that dries quicker than oil paint, and has no smell. It is made in the

following manner: Take fresh curds, and bruise the lumps on a grinding-stone, or in an earthen pan, or mortar, with a spatula or strong spoon. Then put them into a pot with an equal quantity of lime, well slacked with water, to make it just thick enough to be kneaded. Stir this mixture without adding more water, and a white-coloured fluid will soon be obtained, which will serve as a paint. It may be laid on with a brush with as much ease as varnish, and it dries very speedily. It must, however, be used the same day it is made, for if kept till next day it will be too thick: consequently, no more must be mixed up at one time than can be laid on in a day. If any colour be required, any of the ochres, as yellow ochre, or red ochre, or umber, may be mixed with it in any proportion. Prussian blue would be changed by the lime. Two coats of this paint will be sufficient, and when quite dry it may be polished with a piece of woollen cloth, or similar substance, and it will become as bright as varnish. It will only do for inside work; but it will last longer if varnished over with white of egg after it has been polished.

226. *The following receipt for milk paint* is given in "Smith's Art of House Painting:" Take of skimmed milk nearly two quarts; of fresh-slacked lime about six ounces and a half; of linseed oil four ounces, and of whiting three pounds; put the lime into a stone vessel, and pour upon it a sufficient quantity of milk to form a mixture resembling thin cream; then add the oil, a little at a time, stirring it with a small spatula; the remaining milk is then to be added, and lastly the whiting. The milk must on no account be sour. Slack the lime by dipping the pieces in water, out of which it is to be immediately taken, and left to slack in the air. For fine white paint the oil of caraway is best, because colourless; but with ochres the commonest oils may be used. The oil, when mixed with the milk and lime, entirely disappears, and is totally dissolved by the lime, forming a calcareous soap. The whiting or ochre is to be gently crumbled on the surface of the fluid, which it gradually imbibes, and at last sinks: at this period it must be well stirred in. This paint may be coloured like distemper or size-colour, with levigated charcoal, yellow ochre, &c., and used in the same manner. The quantity here prescribed is sufficient to cover twenty-seven square yards with the first coat, and it will cost about three halfpence a yard. The same paint will do for out-door work by the addition of two ounces of slacked lime, two ounces of linseed oil, and two ounces of white Burgundy pitch: the pitch to be melted in a gentle heat with the oil, and then added to the smooth mixture of the milk and lime. In cold weather it must be mixed warm, to facilitate its incorporation with the milk.

227. *A paint for outside work, called Anticorrosion*, is sold in London. It is made of ground glass bottles, scoria from lead-works, burned oyster-shells, and similar materials, mixed with the usual colouring pigments. It is sold in powder, and when to be used it is worked up with raw linseed oil. It is more difficult to lay on than common paint, and wears out the brushes fast; but it is cheap and extremely durable, never blistering, and, if well done, lasting a lifetime: hence it is much employed in government works: it is particularly good for protecting cast iron, stones, tiles, &c.

228. *The following methods of preserving wood* do not properly come within the usual practice of the painter, but they are useful on particular occasions.

229. *Charring the outside of wood* that is put into the ground, as the ends of piles, posts, and wood laid in the foundations, was practised by the ancient Romans, and is found very effective, as charcoal is perfectly incorruptible.

230. *Coal tar* is much better calculated to preserve outside wood and iron, as well in land as in water, than vegetable tar. It is procured by the distillation of coals in making coke, or coal-gas. Its unpleasant smell and blackish colour are objectionable in many situations, but the former wears off in a few months.

231. *Tar varnish* is made by melting common tar over a slow fire, and stirring in as much coal-dust or powdered charcoal as will make it thick. If required to be brown instead of black, put Spanish brown instead of charcoal.

232. *The tar obtained in the manufacture of pyroligneous acid* has been recommended by the late Mr. Parkes as the best preservative of every kind of wood fence. For this purpose, it should be gently heated in an iron pot, and laid on with a brush. It soaks into the wood, and seems to leave "no body," as the painters express it; but after some days' exposure to the sun, the surface and texture of the wood will be much altered, for it will be so hard and impervious, that it will be very difficult to make any impression on it. If a second or a third coat of the tar be laid on, it will then bear out. When these are dry, if required for ornamental work, it may be painted in oil in the usual manner.

233. *A coating to preserve wood in damp situations* may be made by beating twelve pounds of resin in a mortar, and adding to it three pounds of sulphur and twelve pints of whale oil. This mixture must then be melted over a fire, and stirred well while it is melting. Ochre of any required colour, ground in oil, may be put to it. This composition must be laid on hot, and when the first coat is dry, which will be in two or three days, a second coat may be given; and a third, if necessary.

234. *Gas tar*, with yellow ochre, makes a very cheap and durable green paint for iron rails and coarse woodwork.

235. *Composition to lay on a boarded building, to resist the weather, and likewise fire.* Take one measure of fine sand, two measures of wood ashes well sifted, three of slacked lime ground up with oil, and mix them together; lay this on with a brush, the first coat thin, the second thick. This adheres so strongly to the boards covered with it, that it resists an iron tool, and the action of fire, and is impenetrable by water.

236. *A flexible paint for canvass* is made by stirring into fifty-six pounds of common oil paint a solution of soap lye, made of half a pound of soap and three pounds of water: it must be used while warm.

237. *A black colouring for garden walls* may be made by mixing quicklime, lampblack, a little copperas, and hot water.

238. *A method of rendering fish-oil applicable to the purposes of painting* was communicated by Mr. Vanherman to the Society of Arts; and it appears to be a good and cheap vehicle for paint for out-door work which is much exposed to the weather. "Add to thirty-two gallons of vinegar twelve pounds of litharge and twelve pounds sulphate of zinc, shaking the mixture well twice a day for a week. The mixture is then put into a tun of fish-oil, with which it is well shaken and mixed; and the next day the clearer part, about seven eighths of the whole, is poured off. Twelve gallons of linseed oil and two of oil of turpentine are then added to the clear part, and this, being well shaken together, is left to settle for two or three days, when it will be fit to grind white-lead and all the fine colours in: these, however, are to be thinned for use with linseed oil and oil of turpentine."

Subsect. 8.—*Fresco Painting, and Encaustic.*

239. *Fresco is a kind of painting performed with water colours on a ground of stucco* while it is still wet, and admits of the colours sinking in, and drying with the stucco. It is extremely durable, and bears washing without injury; but it is very difficult to execute, because it must be performed with great rapidity, on account of the necessity of beginning and finishing a part while the stucco is still moist, on which account a picture cannot be sketched in, and carried on gradually, as in oil, since no more ground ought to be laid in one day than the painter can cover in that time; and he must complete immediately the painting on that portion, since the work cannot be retouched, except by distemper, which is imperfect.

It was much in use among the ancients, but their paintings in this way were not highly finished. Several considerable pictures have been executed in fresco by the great masters; but this art is little practised at present, although its durability makes it desirable that it should be employed in certain situations.

240. *Encaustic painting* was a method practised by the ancients, and which, though it has been tried with some success on the Continent, is not used in this country, although a few successful experiments have been made here. It consists in making use of wax as a vehicle for the colours, sometimes mixed with oil to render it more liquid, and then by heating the work with a chafing dish the tints are blended. This kind of painting has durability to recommend it.

Subsect. 9.—*Bronzing.*

241. *Bronzing* is a term applied to a common method of painting wood or iron work, or articles of plaster of Paris, such as busts, statues, &c., so as to imitate bronze. Real bronze acquires in time a coat of a dark green colour, owing to oxydation; but any parts of such bronze that may happen to be exposed to rubbing of any kind will have this crust worn off, and be made to assume a bright metallic colour. In bronzing, this effect is imitated. The first part of the process is to paint the whole over of the dark green just mentioned, which is done by a mixture of Prussian blue, yellow ochre, and verditer ground in oil. When two or three coats of this are nearly dry, but not quite, being still a little sticky, or, as it is technically named, *tacky*, a powder, called bronze powder, is rubbed, by means of a linen pad, on all the edges or places liable to be worn bright had the articles been really of bronze and exposed to friction. Bronze powder is sold in the shops on purpose, and is made by grinding Dutch foil and mosaic gold, or precipitated copper, to powder. When well done, the imitation of ancient bronze is very complete.

Subsect. 10.—*Paper-hanging.*

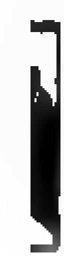
242. *The most usual mode of finishing the walls of apartments* at present is by covering them with ornamental printed papers, of which there is a great variety, from 1*d*. per yard to several shillings. The art was borrowed originally from the Chinese, by whom it has been practised from time immemorial. The colours employed are of distemper: a ground is first laid, and the patterns are printed by means of blocks and various colours, as in calico printing. The variety in the patterns of printed papers is endless, and is continually changing with fashion; gilding is frequently introduced in rich papers. The French have long excelled us in the designing of papers for this purpose, as they have in almost all architectural ornaments; and it is lamentable to see that the best papers in our shops in the present day are imported from France. Some of these contain

figures and landscapes of great merit, and the ornaments and flowers are exquisite. There are several modes of manufacturing papers for hanging. *Paper with a satin ground* is said to be produced by rubbing on the ground powdered French chalk (a variety of steatite) with a hard brush, till the lustre is produced. *Flock paper* is made by printing the pattern on the paper with some kind of varnish, and strewing this over with what is termed *flock*, produced by cutting to a fine powder woollen rags or pieces of cloth by means of machinery. This operation causes the pattern to appear as if it were cloth cut out and fixed on. In some of the best papers, the patterns are partly painted by hand. Some paper, finished with varnish, will bear washing, which is useful in places where it is liable to be much soiled; but the gloss has an unpleasant appearance, and such papers are not fit for elegant apartments.

SUBSECT. 11.—*Sun Blinds.*

243. *Sun blinds* are, in many situations, very necessary for keeping the apartments cool in summer, and for protecting the curtains, carpets, and other inside furniture, from the sun's rays, which are injurious to colours. They can scarcely be considered as ornamental in an architectural point of view, but they are tolerated on account of their great utility. They are placed either on the outside or inside of the sash; but are most effective in the first mode, because the sash and glass are thus protected from the heat, and, of course, the air in the apartment kept of more equal temperature. The simplest

kind of outside blinds consists merely of a piece of cloth fixed to the top of the window, and either hanging down, or stretched out a little way at the bottom by some support. This is the most usual sun blind employed in Italy, and may be seen in pictures of that country, generally resting at bottom on a balcony often filled with flowers. They are usually made of striped cloth or canvass, and hence have a very picturesque effect. These are occasionally used here, but usually with a spring roller at the top, in a frame. Those termed by us *Venetian blinds*, are made of a number of narrow slips of wood, hung horizontally, as *fig.* 48, so that, when turned one way, they touch each other, and fill up the whole opening; but when moved a little, the surfaces are inclined, and then the edges being apart, they admit the air, though they exclude the sun's rays: the laths are confined at their ends by frames in the reveals of the windows, and they draw up entirely into a box or cornice fixed at the top. Blinds of the same kind are often placed at the inside of the sash, and then they turn upon lines of tape; but when they are upon the outside, a brass chain is employed, as being more durable. These are effectual in keeping off the sun's rays. *Shutter blinds* are a cheaper kind, which serve both as Venetian blinds and outside shutters: they are made of strong laths or luffer boards, either fixed in the frame, or turning all together by a lever handle, on pivots in the frame. When opened, they are fastened back like outside shutters. They are useful in windy situations, and where security is required. The latest improved blinds, and those now most generally used, are the *bonnet blinds*, *a*, *fig.* 49. They are of striped cloth, fixed to an iron framing at bottom, and are made to rise, by a rather complicated system of cords and pulleys, into a case of wood at the top of the window, and which is generally made ornamental. In these the sides are filled up, to exclude the oblique rays of the sun: *b* is the manner in which they are made for bedchamber apartments.



b

a *Fig.* 49.

SUBSECT. 12.—*Bell-hanging.*

244. *Bell-hanging is performed by the smith*, and requires great attention. A bell should ring with a very slight exertion of the hand, and it should ring a sufficient time, and not too long, so as to be sufficiently heard where the servants are placed. The bell itself (*fig.* 50) is fixed to an elastic spring, by which it vibrates on being pulled by the wire; and there is another spring of spiral wire, to prevent the vibration from being too great. The wires are carried round the angles of apartments by means of cranks, which are of various kinds, to suit the external and internal angles. In some cases the wire or bell rope goes to the ceiling of the room, but now usually only down from the surbase moulding, where it may be rung by a small brass lever, or some other contrivance. The bell wires are always of copper, as iron would decay by rust.

Fig. 50.

245. *An improvement in the method of disposing of bell wires* has been announced as

practised in Edinburgh. Instead of causing the wires to go along beneath the cornices, and across partitions and passages, in the usual manner, till they reach the bells they are designed to pull, a plan is followed by which not a single wire is seen in any room in the house. From the top of the bell-pull in each apartment the wire is carried straight upward in a small tin tube sunk in the plaster, to the vacancy below the slates; here the wires of the whole house meet, and from thence descend in another tube, branching off to their respective bells. By this means each wire has only two cranks, or at most three, in its entire course: all boring of partitions is avoided, and also the appearance of wires in the rooms.

246. *It is convenient to arrange all the bells in the basement story in a line*, each having the name of the apartment it belongs to; for though in a small house the servant knows each bell by its sound, yet when there are many this may be difficult; but on going to the place where they are hung, it may be seen which bell has rung by something of the vibration being still visible.

SUBSECT. 13.—*Verandas and Balconies.*

247. *The Veranda is an ornamental addition borrowed from India*, where the climate demands every assistance from shade. Although they are not equally necessary with us, yet they are often useful, and have an appearance extremely agreeable when tastefully attached to a country residence. They do not unite well with architectural decoration, but have this advantage, that of themselves they give an air of elegance to a house otherwise extremely plain. The framing is generally formed of wood painted; and in case of being highly enriched with ornament, cast iron has been found both durable and economical. The roofs are painted oil cloth, sheet copper, zinc, or tinned iron painted. Care should be taken that the balconies are sufficiently strong, and securely fixed in the wall. Not being necessarily connected with any particular style of architecture, they are capable of endless variety in their design.

248. *Balconies* are well known, and are made of stone or iron, and of various patterns. When of iron, it is an important precaution not to place the bars at such a distance that a child coming into the balcony can get its head between; since cases have occurred (and the writer of this article was witness to one) where a child, having put out its head between the bars, could not by any means draw it back again, and a smith was obliged to file or saw the bars through before the child could be extricated from this dangerous situation.

SUBSECT. 14.—*Decorative Sculpture and Carving.*

249. *There is generally more or less of these in every modern house.* The talents of the sculptor in marble are exercised occasionally in statues, bas-reliefs, vases, and other ornaments, as likewise in capitals and other parts of columns, and in chimney-pieces; but this material is too expensive to be in general use among us. Few of our native stones are fit for durable architectural sculpture, with the exception of one variety of magnesian limestone that has been employed for the sculpture in the triumphal arch before Buckingham Palace: Portland stone has been a good deal used; but it is coarse, and, except selected with care, not very durable, as may be seen in some of our public buildings. Bath stone is easily carved, but is less durable than Portland. This deficiency in a good material has led to the invention of various kinds of artificial stone.

250. *Coade's artificial stone* was at one time much in use for architectural ornaments. It is a sort of pottery, and easily worked, when soft, into any form: it is perfectly durable, but liable to warp in baking.

251. *Ranger's artificial stone* is composed of fresh-burned lime and sand, put into moulds: this sets extremely hard, and has been employed with some success in building.

252. *Austin's artificial stone* is excellent for architectural ornaments of all kinds, as vases, statues, chimney-tops, &c., and is now much in use. Ornaments in plaster of Paris we have mentioned when describing the business of the plasterer; and those made in Parker's cement when treating of stucco.

253. *A great variety of ornaments*, particularly light Gothic enrichments, are now made with advantage in cast iron.

254. *Carving in wood*, at one time carried to such perfection, has declined through the inventions of a *composition* of whiting and linseed oil, in which ornaments are cast and fixed on to wood with glue; and also by the employment, now so very general, of *papier-machée*.

255. *A process for imitating wood carving* may be mentioned as one of the novelties of the day. It is the invention of Braithwaite. The wood, instead of being cut as in the usual manner, has the pattern burned out by the application of a heated metal mould, and the charcoal so formed is brushed out after each successive application of heat, until sufficient depth is acquired. Care, of course, must be taken that the wood does not inflame during the process: this is prevented by wetting the wood.

256. *Papier-machée* is a very elegant manufacture, now much employed for forming

ornaments, as a substitute for carving, and casts in plaster of Paris. It is made of a pulp from rags or paper, which, being mixed with size and glue, and cast in a mould, becomes extremely hard when dry. It is much used for flowers and other ornaments in the ceilings, and various other places in apartments. There are several manufactories of it, one of the best of which is Messrs. Bickfield & Co., London. These ornaments are much less liable to break than those of plaster.

If decorations of a sculptural kind are introduced, the design and execution should display good taste; otherwise they are better entirely omitted.

257. *Scagliola* is a very beautiful imitation of coloured marble, and porphyries; so close an imitation, indeed, that, without a near inspection, it cannot be distinguished from these stones. It is much employed in internal decoration, for columns, pedestals, and various supports of statues and vases, and sometimes to cover parts of the sides of apartments. It is composed chiefly of plaster of Paris, with colouring matters, cemented by glue, and having sometimes fragments of alabaster inserted, to imitate verd antique. From the nature of its composition, it is not fit to be exposed to the weather out of doors, and requires to be kept dry; but answers admirably in interiors, where great richness at a small expense is required.

Subsect. 15.—*Water-pipes.*

We have already mentioned the necessity of an abundant supply of good water in every spot where it is resolved to build, either from wells, rivers, or by some artificial means. In most cities of England this is now well managed by means of public water-works, that supply every house with this great necessary of life. The disposing of the water-pipes and cisterns in a building should not be left to the plumber only, however skilful; but all the details should receive the attention of the architect, in designing, when provision can be made for placing the pipes properly, which, if not done at first, may sometimes be found difficult or inconvenient afterward.

258. *In London* [and still more in New-York, and some other American cities] *the abundance and cheapness of the supply of excellent water by means of the water companies* is admirable, notwithstanding the outcry raised by ignorant or unprincipled persons: in many parts of the metropolis water can be served to the upper stories from the ordinary sources; and when this cannot be done, it may be elevated sufficiently high by force pumps.

259. *The advantage of having water laid on in the bedchamber stories* to supply baths,* or for other purposes, is too obvious to require being stated, and should not be neglected in a new house, where the expense does not forbid so great a convenience. Wherever there is any degree of complexity in the pipes or other apparatus necessary for the supply, an accurate drawing should be kept of the whole, that may give the requisite information in case of repairs or alterations. For the properties of good water, and the methods of filtering, we refer the reader to the article in this work on that subject, Chap. I., Book VIII.

260. *To prevent the water in the lead pipes from freezing* in winter, which frequently causes them to burst by the expansion of the ice, any portion that is exposed to the external air should, at the commencement of a frost, be well wrapped round by some non-conducting substance, as straw; and in case of the pipe passing through the house, it is a good plan to have a cock on the part of the service-pipe where it enters, which being shut as soon as the cistern is filled, the pipe may be emptied of water, and remain so until the water comes on again, by which means all danger of the water freezing in the pipes may be avoided, a circumstance which, when it happens, is very annoying.

261. *The construction of cisterns* with *ball-cock* and *waste-pipe* is too well understood to require being mentioned in detail: the first being to prevent the water running after the cistern is full, and the last to prevent the cistern from overflowing in case of any accident to the former. It is a good precaution to lay the pipes in such a manner that they can be easily got at, in case repairs should be necessary. Sinking and forcing pumps are provided by the plumber.

262. *For pumps*, see "Kitchen Furniture," Book XI

Subsect. 16.—*Water-closets.*

263. *The great utility of water-closets* is so well known that little need be said on the subject, but that they are indispensable in every house where comfort is aimed at. As they are very troublesome when out of order, some pains should be taken to select one of good construction; and it is better to give a higher price than, through too great economy, to run the risk of getting one imperfect. Various patents have been taken out for this apparatus; but we believe that no construction is superior to the original one, that by the late Bramah. The general principle of all is the same: a cistern of water is placed above, and in the bottom is a valve, which is opened by the motion of the han-

* [In the city of New-York all these, and still greater advantages, are furnished to the citizens at a very low rate by the municipal authorities, who have introduced pipes conveying pure water from a river forty miles distant, the particulars of which are related in a subsequent part of this volume.]

dle on the seat, by which the water rushes down into the basin, while the same handle, by means of a lever, opens another valve below in the soil-pipe, the water passing through it. It is scarcely possible to render a description intelligible, without inspection of the apparatus itself.

264. *A simple and cheap water-closet* is the following: *a*, *fig*. 51, is the earthenware basin, the lower end of which terminates in a neck that dips under the water in a leaden vessel, from which a pipe descends to the drain. *b* is the cistern of water placed above at a proper height: this cistern has a waste-pipe, *c*, which not only prevents the water in the cistern from overflowing, but it also goes into the leaden vessel, and keeps it filled every time the water comes on, thus preventing that part from becoming ever dry, if it should not be used. The supply to the basin is by a pipe, *d*, coming from the cistern, and having a valve at the bottom, seen on a larger scale at *e*: this valve is raised, when water is required for the basin, by pulling a string, attached to one end of a small lever, fixed on the edge of the cistern, to the other end of which is a chain that raises the valve. The lower end of the basin being thus always under the water, no foul air can ascend. Some, instead of this valve and lever, put a cock on the pipe, *d*, which may be turned when necessary; and this cock, if brought to the seat, may be turned by a handle similar in appearance to the better kind of water-closets: but the cock does not afford sufficient water way, which occasions the water to flow too slowly; whereas the valve may be made of any size, and may, therefore, give a sufficient and sudden supply.

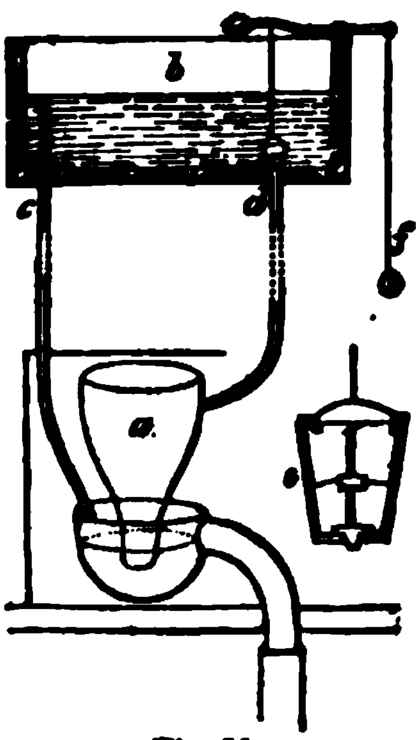


Fig. 51.

265. *Portable water-closets* are described under "Furniture."

266. *Privies to be used without water* may be constructed in various ways. One is, to have a basin, as in a water-closet; and to continue down from it a tube so far into the cesspool below as to prevent the rising through it of air, and, consequently, of smell. If all the waste water of the house is poured into the basin, neither that nor the tube will ever be choked up; in which case, this construction may be considered one of the best for preventing smell. Another mode is to have no basin, but to take care that the surface of the cesspool exposed to the air is no larger than necessary, and that the seat be secure and free from crevices. It is best to have, besides the usual circular cover, another square, large cover, such as is used in water-closets.

267. *An ingenious contrivance was invented by Mr. Strutt, of Derby*, and employed in the Derbyshire infirmary, by which the air in the place was changed by the motion of the door, which, at the same time, disengaged the water for the closet itself, without any care of the person using it.

SUBSECT. 17.—*Fountains.*

268. *Fountains*, so great a luxury in warm climates, do not appear to be generally wished for in this country; and they are expensive ornaments, except in remarkable cases, where the supply of water is very easily obtained. The principle upon which the simplest kind is formed is sufficiently obvious; the height of the source for the water must be as great as that to which the fountain is to play. Fountains on a very small scale, on the principle of that called Hiero's, are sometimes put into conservatories, and similar places, and then are elegant decorations.*

SUBSECT. 18.—*On rendering Houses fire-proof.*

269. *To render all dwelling houses fire-proof* is obviously desirable; but although many inventions have been made with this view, and experiments have been made sufficient to show that it is quite practicable, yet none of the methods have been found so free from objections of some kind, either on account of the expense, or from some other cause, as to be brought into general use. The chief means proposed have been iron roofs, floors supported by iron or flat brick arches, plaster, or what is called pugging under the flooring boards, stone or iron staircases, brick, or at least brick-nogged, partitions, metal sashes, iron plating round all timbers: in short, using metal, or brick and slate, wherever it is possible, instead of wood. By taking advantage of these, any house may be rendered fire-proof in building, although the expense will be somewhat increased; and, considering that the additional cost need not be very considerable compared with the comfort of security, it is much to be regretted that, in all apartments where valuable property, such as libraries, museums, or galleries of works of art are deposited, means should not be resorted to, to render them safe from destruction by fire; and we add, that it is surprising that the practice of rendering houses fire-proof should not become gen-

* [In the city of New-York, public fountains on a large scale adorn the numerous parks and open squares, while in the gardens, and even at the doors of the citizens, the supply of water is so abundant, that ornamental fountains and jet d'eaus can be placed at a trifling expense, a convenience of which many are availing themselves.]

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We have already mentioned the necessity of an abundant supply of good water in every spot where it is resolved to build, either from wells, rivers, or by some artificial means. In most cities of England this is now well managed by means of public waterworks, that supply every house with this great necessary of life. The disposing of the water-pipes and cisterns in a building should not be left to the plumber only, however skilful; but all the details should receive the attention of the architect, in designing, when provision can be made for placing the pipes properly, which, if not done at first, may sometimes be found difficult or inconvenient afterward.

258. *In London* [and still more in New-York, and some other American cities] *the abundance and cheapness of the supply of excellent water by means of the water companies* is admirable, notwithstanding the outcry raised by ignorant or unprincipled persons: in many parts of the metropolis water can be served to the upper stories from the ordinary sources; and when this cannot be done, it may be elevated sufficiently high by force pumps.

259. *The advantage of having water laid on in the bedchamber stories* to supply baths,* or for other purposes, is too obvious to require being stated, and should not be neglected in a new house, where the expense does not forbid so great a convenience. Wherever there is any degree of complexity in the pipes or other apparatus necessary for the supply, an accurate drawing should be kept of the whole, that may give the requisite information in case of repairs or alterations. For the properties of good water, and the methods of filtering, we refer the reader to the article in this work on that subject, Chap. I., Book VIII.

260. *To prevent the water in the lead pipes from freezing* in winter, which frequently causes them to burst by the expansion of the ice, any portion that is exposed to the external air should, at the commencement of a frost, be well wrapped round by some non-conducting substance, as straw; and in case of the pipe passing through the house, it is a good plan to have a cock on the part of the service-pipe where it enters, which being shut as soon as the cistern is filled, the pipe may be emptied of water, and remain so until the water comes on again, by which means all danger of the water freezing in the pipes may be avoided, a circumstance which, when it happens, is very annoying.

261. *The construction of cisterns* with *ball-cock* and *waste-pipe* is too well understood to require being mentioned in detail: the first being to prevent the water running after the cistern is full, and the last to prevent the cistern from overflowing in case of any accident to the former. It is a good precaution to lay the pipes in such a manner that they can be easily got at, in case repairs should be necessary. Sinking and forcing pumps are provided by the plumber.

262. *For pumps*, see "Kitchen Furniture," Book XI

Subsect. 16.—*Water-closets.*

263. *The great utility of water-closets* is so well known that little need be said on the subject, but that they are indispensable in every house where comfort is aimed at. As they are very troublesome when out of order, some pains should be taken to select one of good construction; and it is better to give a higher price than, through too great economy, to run the risk of getting one imperfect. Various patents have been taken out for this apparatus; but we believe that no construction is superior to the original one, that by the late Bramah. The general principle of all is the same: a cistern of water is placed above, and in the bottom is a valve, which is opened by the motion of the han-

* [In the city of New-York all these, and still greater advantages, are furnished to the citizens at a very low rate by the municipal authorities, who have introduced pipes conveying pure water from a river forty miles distant, the particulars of which are related in a subsequent part of this volume.]

dle on the seat, by which the water rushes down into the basin, while the same handle, by means of a lever, opens another valve below in the soil-pipe, the water passing through it. It is scarcely possible to render a description intelligible, without inspection of the apparatus itself.

264. *A simple and cheap water-closet* is the following: *a*, *fig.* 51, is the earthenware basin, the lower end of which terminates in a neck that dips under the water in a leaden vessel, from which a pipe descends to the drain. *b* is the cistern of water placed above at a proper height: this cistern has a waste-pipe, *c*, which not only prevents the water in the cistern from overflowing, but it also goes into the leaden vessel, and keeps it filled every time the water comes on, thus preventing that part from becoming ever dry, if it should not be used. The supply to the basin is by a pipe, *d*, coming from the cistern, and having a valve at the bottom, seen on a larger scale at *e*: this valve is raised, when water is required for the basin, by pulling a string, attached to one end of a small lever, fixed on the edge of the cistern, to the other end of which is a chain that raises the valve. The lower end of the basin being thus always under the water, no foul air can ascend. Some, instead of this valve and lever, put a cock on the pipe, *d*, which may be turned when necessary; and this cock, if brought to the seat, may be turned by a handle similar in appearance to the better kind of water-closets: but the cock does not afford sufficient water way, which occasions the water to flow too slowly; whereas the valve may be made of any size, and may, therefore, give a sufficient and sudden supply.

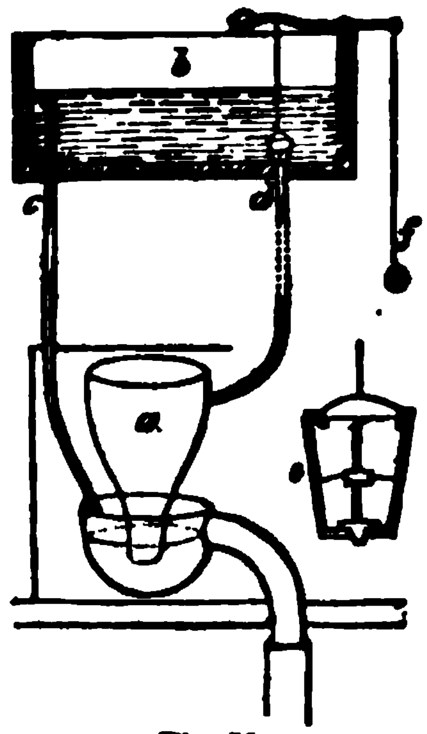


Fig. 51.

265. *Portable water-closets* are described under "Furniture."

266. *Privies to be used without water* may be constructed in various ways. One is, to have a basin, as in a water-closet; and to continue down from it a tube so far into the cesspool below as to prevent the rising through it of air, and, consequently, of smell. If all the waste water of the house is poured into the basin, neither that nor the tube will ever be choked up; in which case, this construction may be considered one of the best for preventing smell. Another mode is to have no basin, but to take care that the surface of the cesspool exposed to the air is no larger than necessary, and that the seat be secure and free from crevices. It is best to have, besides the usual circular cover, another square, large cover, such as is used in water-closets.

267. *An ingenious contrivance was invented by Mr. Strutt, of Derby*, and employed in the Derbyshire infirmary, by which the air in the place was changed by the motion of the door, which, at the same time, disengaged the water for the closet itself, without any care of the person using it.

Subsect. 17.—*Fountains.*

268. *Fountains*, so great a luxury in warm climates, do not appear to be generally wished for in this country; and they are expensive ornaments, except in remarkable cases, where the supply of water is very easily obtained. The principle upon which the simplest kind is formed is sufficiently obvious; the height of the source for the water must be as great as that to which the fountain is to play. Fountains on a very small scale, on the principle of that called Hiero's, are sometimes put into conservatories, and similar places, and then are elegant decorations.*

Subsect. 18.—*On rendering Houses fire-proof.*

269. *To render all dwelling houses fire-proof* is obviously desirable; but although many inventions have been made with this view, and experiments have been made sufficient to show that it is quite practicable, yet none of the methods have been found so free from objections of some kind, either on account of the expense, or from some other cause, as to be brought into general use. The chief means proposed have been iron roofs, floors supported by iron or flat brick arches, plaster, or what is called pugging under the flooring boards, stone or iron staircases, brick, or at least brick-nogged, partitions, metal sashes, iron plating round all timbers: in short, using metal, or brick and slate, wherever it is possible, instead of wood. By taking advantage of these, any house may be rendered fire-proof in building, although the expense will be somewhat increased; and, considering that the additional cost need not be very considerable compared with the comfort of security, it is much to be regretted that, in all apartments where valuable property, such as libraries, museums, or galleries of works of art are deposited, means should not be resorted to, to render them safe from destruction by fire; and we add, that it is surprising that the practice of rendering houses fire-proof should not become gen-

* [In the city of New-York, public fountains on a large scale adorn the numerous parks and open squares, while in the gardens, and even at the doors of the citizens, the supply of water is so abundant, that ornamental fountains and jet d'eaus can be placed at a trifling expense, a convenience of which many are availing themselves.]

eral. But the description of the details respecting the various methods that would effect this object would far exceed the limits of this work.

The importance of this for a house built in the country must appear so much the greater, where that assistance from fire-engines cannot be had that towns afford.

BOOK II.

ON WARMING DOMESTIC EDIFICES.

CHAPTER I.

ON HEAT.

270. *Introductory Remarks.*—The various modes of producing an agreeable temperature in our apartments, at all seasons of the year, are important to be understood. Many uncivilized nations, accustomed to a life of hardship, and passing their time chiefly in the open air, are rendered nearly insensible to slight changes in its temperature, and the comforts of domestic life are little known to them.

271. *A few centuries ago, the inhabitants of this country*, whose time was spent principally in war and the chase, appear to have attached little importance to their ordinary domestic edifices; and while their ecclesiastical buildings, their palaces, and castles, displayed the skill of the architect, the habitations of private individuals were, in general, only wooden buildings of mean appearance and inconvenient arrangement. The habits of modern life require the interior of our houses to be objects of more attention, and the infinite number of pursuits causing a great part of our time to be passed within doors, make it necessary, both for health and the advantageous employment of our faculties, that we should not suffer from cold or deleterious air, while deprived of that bodily exercise which imparts warmth and animation to those whose employments carry them chiefly into the open air.

272. *In the southern parts of Europe*, indeed, artificial warmth is so seldom required, that the means of obtaining it are even now exceedingly rude and imperfect, frequently amounting to no more than introducing a charcoal stove, or, rather, a brazier, or open vessel filled with burning charcoal, into the apartment, a practice which would be extremely injurious to health if continued for any length of time. But in this country, where the cold season is not only more severe, but of much longer duration, various modes are adopted which are much less objectionable. Still, we are far from being under the necessity of employing the methods used in the north of Europe, where nothing less than close stoves, which produce no change of air in the apartments, are sufficient to ensure the degree of warmth essential to comfort.

273. *When we treat of Ventilation*, we shall explain particularly why this change of air is so important to health: at present, we shall consider this to be admitted; and we may do so the more readily, as the subject is beginning to be generally attended to. It is desirable, therefore, in the method we may adopt for warming our buildings, to contrive not only the most economical, but also that which will secure to us the enjoyment of a salubrious atmosphere.

But as the subject of warming and ventilating cannot be understood without an acquaintance with the properties and laws of heat, we shall inquire into the nature of this agent previously to pointing out the most judicious manner of directing and employing it.

SECT. I.—ON HEAT.

274. *Heat is recognised as a principle rather by its effects than by any knowledge we possess of its essential nature.* Every one experiences the presence or absence of it in the sensations of warmth and of cold; and we all witness the changes produced by it on other bodies, in causing them to expand, or to melt; and likewise in the process of combustion. But if we inquire, what is this heat, the effects of which are so evident? the answer is not so easy.

By some, heat has been considered as an extremely subtile fluid, capable of insinuating itself between the particles of all bodies; of remaining there in a dormant and inactive state, or of being put in motion or activity, by which only it is rendered sensible. This supposed fluid has been named *caloric*.

By others, the existence of any such peculiar fluid is denied, and heat is said to consist merely in a rapid motion of the solid particles of bodies that are heated. A third opinion is, that heat depends upon the rapid vibrations or waves of an inconceivably subtile fluid, or ether, which fills all space, and is quite independent of the ordinary matter appreciable by our senses.

Since all these opinions are hypotheses only, and as neither of them can be completely proved in the present state of our knowledge, we may speak of heat as a distinct substance, which is the doctrine that can be most easily adapted to the explanation of the

usual phenomena we shall have to consider; observing, that we do so for convenience only, without intending to express any opinion as to its absolute truth; and we shall proceed to describe some of the properties of heat, which are essential to our present subject, as they have been deduced from experiment, and entirely independent of every speculation respecting its essential nature.

275. *Heat has a strong tendency to diffuse itself equally through all adjoining bodies;* so that if several bodies, heated to different degrees, are brought together, either in contact or near one another, those which have most heat will give out some to those which have least, until they have all an equal quantity. This is one of its most important properties, and is usually expressed by the term *propagation of heat.*

276. *Heat is propagated in two ways:* by *conduction*, and by *radiation*. When bodies are actually in contact, the superabundant heat of the one passes directly into the other, and diffuses itself through it until the quantity in both be equal: this is propagation by conduction. When heat is propagated by radiation, a heated body sends out invisible rays of heat in all directions through the air, which strikes upon and enters into all adjoining solids; tending, in like manner, to equalize their temperature.

277. *An increase of heat causes all bodies to expand*, or *become larger in their dimensions.* This is easily shown by a few simple experiments. 1. With regard to solids: procure a small cylinder of metal, *a*, and also a plate of metal, *b* (*fig.* 52), having a notch cut in it exactly equal to the length of the cylinder; make also a hole in this plate so large that the cylinder may just fit it. Now heat the cylinder in the fire, and, on applying it to the notch, it will be found to be increased in length by its no longer fitting it; and the thickness will likewise be found greater, as it can no longer be pushed through the hole in the plate. When the cylinder cools, it will shrink again to its former size. By similar observations on other substances, it will appear that all expand by heat, and contract by cold or the decrease of heat; but some more than others: metals expand most, and glass is among the least expansible; wood expands and contracts considerably across the grain, but very little in the direction of the grain; thus a bar of wood varies in its length less than a bar of iron.

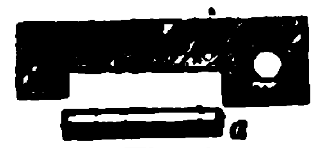


Fig. 52.

278. *The expansibility of liquids is seen distinctly in the thermometer*, where the quicksilver rises and falls in consequence of the increase and diminution of its bulk, as the weather becomes warmer or colder. *To observe how air expands*, lay a half-blown bladder before the fire, and in a few minutes the air within it will swell so much that the bladder will be completely extended; but when it is removed from the fire, the air, as it cools, will contract to its original bulk.

279. *The shrinking of baked clay*, when exposed to a high degree of heat, may seem to be an exception to the general law just mentioned; but it is only apparently so, for this contraction is owing to the heat expelling the moisture which the clay contained, in consequence of which the parts come closer into contact.

280. *The unequal expansion and contraction of layers of different substances applied on each other* is frequently productive of serious inconvenience. It is this that occasions earthenware to be covered with innumerable minute cracks after some time; and this unequal expansion is also the reason why glass and earthenware are so easily broken by pouring liquids into them suddenly without gradually warming them. The surface where the hot fluid is applied expands before the opposite side has time to do so, and a crack is the consequence. The thinnest glass is the least liable to this accident, because it is soonest heated through. Throwing water upon heated cast iron produces a similar effect, by cooling one side more rapidly than the other.

281. *Heat does not pass with equal facility through all bodies.* Those which permit its passage the most readily are termed *good conductors;* and those through which it passes with difficulty are called *bad*, or *slow conductors* of heat. Metals are the best conductors, and charcoal, wood, glass, earthenware, water, and air are the worst. To illustrate this, heat one end of a rod of iron in the fire, and it will be perceived that the other end will soon become so hot that it cannot be held in the hand, because the heat passes readily from the end in the fire to the other end; but a rod of wood may be held in the fire until one end is burned without the other being heated so that it may not be easily held, because the heat passes with great difficulty through the wood. The same may be experienced with a rod of glass. It is of very great importance, in the management of heat, to know the various powers of substances in conducting it, or, in other words, suffering it to pass through them, or preventing its passage, as upon this depends our means of confining it, so often necessary.

282. *It is obvious that to confine heat, or to prevent it from escaping*, we must surround it with the slowest conductors, of which brick, charcoal, wood, and air are often the most convenient. In general, the densest substances (for instance, metals) permit the passage of heat the most readily; and, on the contrary, the most porous and lightest bodies are the worst conductors and the best confiners of heat. As a few illustrative examples of the application of this principle, we may mention that boiling water may be carried a long way hot by putting it into a thick wooden cask. Wooden handles are put to metallic

tea and coffee pots, or other hot vessels, because wood is a slow conductor of heat. Heat may in a great measure be prevented from escaping from bodies, by being surrounded with pounded charcoal, sawdust, or pumice, or by air confined between plates; and water may be kept long hot, by the vessel containing it being wrapped round with woollen cloth or any light porous material. But as there is no substance a perfect or absolute nonconductor, that is, through which heat will not be transmitted more or less, so we have no means of preventing heat from escaping in some degree: when we wish to confine it, we can only select as a barrier those substances through which it finds its way with the greatest difficulty.

283. *For the same reason, all slow conductors part with their heat with greater difficulty, and retain it much longer than good conductors.* From these principles many facts are easily explained. Brick is a bad conductor, and we have shown that metals are the best. A brick stove will, therefore, be longer in heating through than an iron one, but will be much longer in cooling or parting with its heat. Water is a bad conductor of heat, and so is glass; a bottle of hot water will, therefore, keep long warm, but still longer if wrapped in flannel. Every one has remarked that, after standing some time before the fire, the money in one's pocket feels much hotter than the clothes. This, however, is a deception, for it is not in reality any hotter, as may be proved by the thermometer. Whence, then, the sensation of superior heat in the metal when touched? The fact is, that the metal, from its being the best conductor, parts with its heat more readily to the hand than the clothes, and, consequently, excites in a greater degree the sensation of warmth. If iron, marble, wood, and flannel be exposed to the sun's rays together for a certain time, they will all acquire the same temperature, yet, upon touching them, the metal will feel the warmest; and if they are exposed together to the cold, the metal will soon feel the coldest, notwithstanding the thermometer will show the heat of them all to be equal: the reason will be easily deduced from what we have already said.

284. *It is to be observed that there is no such thing as absolute cold,* cold being only a loss of heat, and not a thing positive. It was at one time supposed that there were rays of cold as well as of heat; but this is now considered to be an error. Nor do we know any substance deprived altogether of heat: although intense degrees of cold can be produced, still it is imagined that we have never arrived at the greatest possible degree of it.

285. *Fluids of all kinds, and air, are much worse conductors than solids;* indeed, they can scarcely be said to conduct heat in the same manner as solids. The particles of solids being fixed, heat is communicated from particle to particle, until it has passed entirely through; but water and air scarcely at all transmit heat in this manner; their parts, being moveable, become expanded by heat, and, consequently, specifically lighter: hence they rise upward when they are heated, and give place for others to be heated in their turn; the several parts of these fluids are, therefore, in constant motion while heating; but if this motion be prevented or obstructed, fluids form the most perfect barriers to heat that are known. It is for this reason that double sashes to apartments are much used in Russia and other northern countries, because the confined air between them does not admit of the passage of heat through it.

286. *Count Rumford found that the nonconducting property of air was much increased by mixing with it some light loose substances,* as wool, or, what is best of all, eider down; and he very ingeniously explains the reason why these and similar substances are so effectual in forming warm clothing. He observes, that "the warmth of the wool and fur of beasts, and of the feathers of birds, is undoubtedly owing to the air in their interstices, which air, being strongly attracted by these substances, is confined, and forms a barrier, which not only prevents the cold winds from approaching the body of the animal, but which opposes an almost insurmountable obstacle to the escape of the heat of the animal into the atmosphere. In the same manner, the air in snow serves to preserve the heat of the earth in winter. The warmth of all kinds of artificial clothing may be shown to depend upon the same cause; and were this circumstance more generally known, and more attended to, very important improvements in the management of heat could not fail to result from it. A great part of our lives is spent in guarding ourselves against the extremes of heat and cold, and in operations in which the use of fire is indispensable; and yet how little progress has been made in that most important art—the management of heat!"

287. *The mode in which heat is communicated to water in our ordinary processes* is a very interesting and useful subject of inquiry. We have already stated that it is not heated in the same way as solids, and we have briefly explained the manner in which its temperature is raised; but as the heating of water forms a very important part of our subject, we must enter more minutely into some of its details.

And, first, it is proper to be known that, until Count Rumford published his very curious observations, it had not struck philosophers that there was any remarkable difference in the mode of heating water or other fluids, and solid substances; and it is worth while to mention the circumstance that led him to make so valuable a discovery, because it points out, in a striking manner, the utility of observing with attention, and reflecting upon, many of the ordinary occurrences that are continually happening around us. Wish-

ing to cool some spirits of wine in a wide glass tube, he placed it in a window; after a short time, casting his eye upon the tube, he observed some particles of dust which had got in moving upward and downward with considerable celerity, and it struck him that these motions were too regular to be accidental. He continued to observe them with attention, and saw that they diminished gradually as the fluid lost its heat, and ceased altogether when it was cold. He found, also, that these motions were renewed upon every fresh application of heat. He afterward converted this into a beautiful experiment by employing minute grains of amber instead of the dust, by means of which the motions were rendered much more visible. Reflecting upon this experiment, and varying it in many ways, he at last was convinced that these motions were entirely owing to currents in the fluid, and that it was by these currents that the cooling, and also the heating of liquids, is effected. When any part of the water is heated, and particularly if it be that at the bottom, which is the case when a vessel full of water is put on the fire, it expands, becomes specifically lighter, and, as we stated above, rises to the surface, and sends down an equal portion to be also heated: when this is effected, the portion sent down rises for the same reason, and displaces another portion; and in this way there is a continual change of place among the parts of the fluid, and ascending and descending currents established, until the whole has received the same temperature. In the case of cooling, the motions will be similar; the surface will cool first, and this water will descend: the same will happen to what arrives at the top, which will also descend when it is cooled, and so on till the whole is equal. From this we may see the reason why water is sooner heated or cooled in a shallow than in a deep vessel: the currents upward and downward having less space to traverse, the change of the whole is sooner effected.

288. It is obvious, from what has been said, that *water cannot be heated, except in a very great length of time, by applying heat to its surface.* This may be easily shown by a simple experiment. Put some cold water into a deep glass tumbler, and hold just over the surface an iron heater made red hot; although the water at the surface will receive some heat, this will not extend downward, and the whole will be scarcely warmed in a very long time. Even if some ether be poured upon the surface, and set fire to, it will burn all away, and yet very little heat will be communicated to the water.

To heat water effectually, therefore, the heat must be applied *at the bottom of the vessel* containing it; little effect is produced even if it be applied to the sides of the vessel.

289. *As it is very important to have a clear idea of various circumstances respecting the boiling of water*, it will be worth while to make the following easy experiment: Fill a Florence flask (one of those in which salad oil is imported) about half full of water, and place it over a spirit lamp, or chafing-dish of charcoal. In a few minutes very minute bubbles will rise from the bottom to the surface; these consist of air that is always combined with water in a natural state, and which, being rendered elastic by the heat, separate from the water. A motion will soon be perceived in the water, which will be more evident if a few particles of dust be thrown into it; this motion is occasioned by the currents which we have already mentioned. At the same time, it will be seen that some bubbles of steam form at the bottom where the heat is applied, and rise upward; but many of these, instead of arriving at the surface, will disappear in the middle, being condensed again by the cold of the water in the upper part. A hissing or simmering will now be heard, owing to the formation of the bubbles of steam; the latter also increase in quantity, and agitate the water in their ascent, which is the cause of what is termed *ebullition.* At last this bubbling becomes rather violent, and much vapour rises from the surface, which shows that the water is near to boiling. The vapour, lastly, becomes steam, and the ebullition is at its height.

If the bulb of a thermometer be plunged into the water thus made to boil, the mercury will gradually rise till it reaches 212°; but it will rise no higher, however long it may be kept there, or however the fire may be urged; by which we find that water cannot be heated in an open vessel to more than 212°. The steam that rises, if examined close to the water, will show the same degree of heat. 212 degrees of Fahrenheit's thermometer (which is that commonly used in England) is called the *boiling point of water*; and as soon as this fluid is heated in a vessel without a cover, or with one loosely fitted on, up to 212°, it is converted into steam, as we have seen in the experiment.

It is necessary, also, to observe here, that, though 212° be the boiling point of water, it is not that of all liquids: thus, spirits of wine boils at 176°; ether at 96°; while, on the other hand, turpentine requires 316°, and mercury even 662°. Salt water requires more heat to make it boil than fresh; and hence, when it is wished for some purposes to make water several degrees hotter than 212°, salt is added to it. Sirup requires 220° to make it boil.

Another fact may be mentioned. The substance of which the vessel is made has some influence upon the boiling points of a liquid: thus, water boils at 212° in a metallic vessel, but in one of glass it will not boil till it is heated to 214°: water, therefore, can be made 2° hotter in a glass vessel than in one of metal.

290. *The boiling of every liquid is merely the conversion of it into the state of elastic vapour* by means of heat; and, since various fluids have different degrees of volatility, they, of

course, boil at different degrees of temperature. Thus, sulphuric ether boils at 98°; alcohol at 176°; water at 212°; turpentine at 316°; sulphuric acid at 546°; and mercury at 662°; scarcely any two liquids agreeing exactly in their boiling points. Of this fact advantage is taken in various processes; for instance, when two liquids, as alcohol and water, having different degrees of volatility, are mixed together, they are easily separated by a heat that shall raise one in vapour but not the other; and this forms the foundation of the art of distillation.

291. *But the pressure of the atmosphere modifies, in a considerable degree, the volatility of liquids*; for if that pressure be more considerable than usual, which is indicated by the barometer being high, it requires more than the ordinary degree of heat to raise the liquid into vapour. In speaking of the boiling points, therefore, we always suppose that the pressure of the atmosphere is that which most usually prevails, or which keeps the barometer up to thirty inches. Water, at this degree of pressure, boils at 212°; but if the pressure be considerably less, and the barometer fall down very low, water will boil or become steam with a less degree of heat. This fact is neglected in speaking on the subject in ordinary cases; but there are other cases when the difference is very striking. For instance, if we ascend a mountain, or even a very high hill, where the barometer would fall sensibly, we should find that water would boil although the thermometer indicated the temperature to be several degrees below 212°; and there, consequently, it would be impossible in an open vessel to heat water up to that point, since, before it reached it, it would be converted into steam; even an elevation of a few hundred feet will make a difference of a degree. In every case, however, when water is converted into steam by heat, it is proper to say that it *boils*, although the temperature may be less than 212°. So accurate is this law, that the heights of mountains are now measured by ascertaining with the thermometer the degree at which water boils on their tops.

292. *A very important application has been made* of this curious fact. As it is possible to exhaust the air over the surface of a liquid in a closed vessel, we can take away the pressure of the atmosphere entirely from it, and thus boil it *in vacuo*; and by this contrivance water can be made to boil even at 72°, which is the heat of the human body.

293. *On the contrary*, if we give additional pressure to the surface of the water, the steam is less easily produced, and the water requires a much greater degree of heat to make it boil, which might be done by forcing in more air upon the surface of the water; but this is not necessary, for the steam itself, if confined where formed, presses, by its elasticity, upon the surface of the water in the same manner as condensed air would do. All that is required, therefore, is to fix down the lid of the vessel in which the water boils, and the steam which begins to form, not being able to escape, will have the same effect as atmospheric pressure; and the temperature of the water may then be raised even to 500° or to 600°, in which case its solvent powers will be proportionally increased.

This is the principle of the vessels called *digesters*, employed in cookery. See "Kitchen Furniture." But as steam, when confined, has a prodigious elastic power, care must be taken that such vessels are sufficiently strong to resist its power, otherwise they would burst, as if by gunpowder, an accident with which, unfortunately, we are too well acquainted in steam navigation. To guard against this, safety valves are necessary; that is, valves which open outward, and suffer the steam to escape through them as soon as its strength becomes too great for the safety of the boiler.

294. *Steam is a particular state of water*; it is aqueous gas, having always the heat of 212°, and is itself quite transparent and invisible, like the common air, while it is kept at that heat; but no sooner is it cooled in the slightest degree than it is condensed into a visible vapour. This may be seen in a common teakettle when it is boiling; the steam from the spout is not visible till it is nearly an inch from the orifice: it issues quite transparent, but soon becomes a little condensed and visible by the cold of the atmosphere. Though the steam that rises from the surface of the boiling of water in an open vessel is visible, being in the state of vapour just mentioned, yet this soon disappears, having been dissolved by the air in which it mingles; but if the vessel be closed, and have a pipe connected with it, as, for instance, with the spout of a teakettle, the lid of which fits very close, the steam may be conducted in a transparent state, and of the temperature of 212°, to a considerable distance, and may be applied to many purposes.

295. *But steam requires to be kept up to this heat* of 212°; for if it meet with any colder substance, it will be robbed of part of its heat, and it then immediately returns to the state of water, which is called the *condensation* of the steam. This may be easily perceived by holding any cold substance in the steam that issues from a teakettle, when it will be condensed in drops of water upon the surface.

296. *Steam is itself, while in that state, perfectly dry*, and it is only when it is condensed that it exhibits moisture, when, in fact, it is returning to the state of water, which, we have observed, it always does when let loose into the atmosphere, or brought into contact with a surface colder than itself. The process of distillation gives a good example of the condensation of steam. The water, by being boiled in the still, rises as steam

into the still head, from which it passes in that state into the worm; it is there condensed, and runs out in the state of a liquid.

297. *We have stated that caloric, or heat, is thrown off from the surface of a solid hot body in straight lines*; and as it proceeds in every direction like radii from the centre to the circumference of a circle, it is said to *radiate* from the body.

That heat is really emitted in this manner, and not conveyed by a current of air or any other means, is obvious from the following considerations. If a heated ball be suspended in the air, heat, which emanates from it, will be felt by the hand at some distance from the ball, and nearly as much below as above the ball; but a current of heated air can only ascend, and therefore could not convey the heat downward; neither can the heat be propagated by the conducting power of the air, for this fluid is almost a perfect nonconductor of heat. It is *radiant heat* that we receive from the sun, and it is likewise radiant heat which we feel in approaching a common fire, which sends off rays, as we have stated. The rays of the sun's heat are always accompanied by those of light, these forming two distinct sets of rays; but heated iron can radiate heat unaccompanied by light; and the rays of heat from a fire are not exactly of the same nature as those of the sun: for instance, the latter pass readily through a pane of glass, but the heat from the fire is almost entirely stopped by the glass.

298. *When the rays of radiant heat strike upon the surface of a solid body, they are either reflected from the surface, or are absorbed by it*: in general, both these effects partly happen. The reflection of heat follows very nearly the same laws as that of light. (See the Chapter on Light.)

The rays from the sun proceed in lines parallel to each other, and, as is well known, may be collected into a focus by a concave mirror, so as to set fire to substances placed in the focus; but the *rays of heat, as well as of light from a candle or lamp, always diverge*; and the rays from a fire proceed from it in all directions.

We may observe, that the radiation of heat from the sun, when accompanied by light, has long been known; but it is a modern discovery that heat radiates likewise from every hot body, even if not luminous, as a piece of heated iron, in invisible rays, that are subject to the same laws of reflection as those that are accompanied by light. The reflection of this heat is practically well known in some cases to the cook, who places a tin screen to reflect heat upon meat when roasting; but all bodies reflect, in a radiant manner, heat which strikes upon them: polished surfaces reflect most heat as well as light.

299. *Such part of the radiant heat as strikes upon a body and is not reflected, is absorbed by it*, for no part of the heat is lost. The heat which is absorbed remains in the body, and raises its temperature: and as it is the remainder after reflection only that is absorbed, it follows, of course, that those substances which reflect the most absorb the least; thus pieces of polished metal, as, for example, fire-irons, placed near the fire, will reflect more heat than equal pieces not polished, but will not themselves become so warm in the same time as if they were not polished, and, of course, can be more easily handled.

300. *It has lately been discovered that heated bodies radiate heat very differently, according to the nature of their surface.* If a surface be polished, it will *radiate* less when heated, though it will *reflect* more heat than if it be rough: thus, a polished teapot full of boiling water will radiate heat, or, in other words, part with its heat, more slowly than if it is not polished; and, of course, vessels of polished metal are more effectual in keeping things hot than those of any substance not polished. This principle has been applied practically in many ways, which may easily suggest themselves. A teakettle or a coffeepot, kept bright, will preserve their contents longer hot than if suffered to become dull; and, on the contrary, an iron stove, to warm an apartment, should always be dull, and not polished, since it is to give out heat, and not to retain it. It is observed that metals are the worst radiators.

301. *Colour has a considerable influence upon the absorbing power of bodies*, and, of course, upon the degree to which they are heated by calorific rays. Black colours absorb most heat, and white the least. To show this, pieces of cloth of different colours have been laid on snow, and it was found that, when the sun shone, the snow was melted most under the black cloth, and least under the white; the other colours absorbed in the following order next to black: blue, green, red, and yellow. Hence a black hat or coat will become warmer in sunshine than a white one. The degree in which these colours reflect heat will, of course, be in the contrary order to that in which they absorb.

302. *Transparent bodies are scarcely at all heated by the rays of heat in their passage through them*: thus those from a fire do not warm the air of the room immediately. The manner in which heat is communicated to the air from the fire is the following: The rays of heat proceeding from the fire strike against some solid objects on the sides of the apartment; and such part of them as is not reflected is, as we have stated, absorbed, and acts in warming what they strike upon; the parts so warmed then communicate a portion of their heat to the air immediately in contact with them by the *mode of conduction* explained above. This portion of air becomes expanded, rises, as in the heating of water,

and is succeeded by another portion of air, which also receives heat by conduction; and thus, as long as the fire continues, it first warms the solid bodies by radiation, and then the air in contact with them, by conduction. In the same manner, the rays of heat thrown upon water from a burning-glass would have very little effect, if any, upon the water, except that it strikes upon the bottom of the vessel and warms it, the bottom communicating the heat so received to the water.

303. *The sense of touch, which affords us the most obvious means of learning the presence of heat, is a very inaccurate measure of its quantity.* Whatever has a higher temperature than our hand at the time will feel warm on touching it, because heat will then pass from it to us; and, on the contrary, whatever has less heat than our hand will feel cold, because, on touching it, heat will leave our hand. Hence the apparent temperature of any body is merely relative to that of our bodies at the time, and not dependant upon its actual temperature. A good conductor of heat, as a piece of metal, will impart heat more freely, and absorb or abstract it more rapidly, than a bad conductor, such as a piece of wood, and hence will appear hotter or colder than the latter, though their actual temperatures be the same. If, therefore, we were to depend upon the touch alone in ascertaining the temperatures of different bodies, we should fall into many errors.

304. *The only accurate mode of measuring the degree of heat is by the use of the thermometer*, which is a little instrument of indispensable necessity in many domestic processes. It consists of a glass tube, having a ball or bulb blown at one end, the bulb and part of the stem being filled with some fluid, the expansion and contraction of which, by heat or cold, marks the change of temperature in any substance it is plunged into. A simple rod of metal expands and contracts, as we have stated, but the change is too small to be easily measured. Fluids expand much more than solids, and mercury is found to be the most convenient fluid for ordinary thermometers. The fluid in the bulb, when it expands, forces its way up the bore of the stem, which being extremely fine, the rise or fall is easily perceived on the least change of bulk, and, consequently, of temperature: a scale is attached to the stem for the purpose of measuring this. Two principal points are first marked on the scale: that where the mercury sinks to when the bulb is plunged into ice, or water just freezing, which is called the *freezing point*; and that where the mercury would rise to when the instrument is put into boiling water is called the *boiling point*. The first is marked 32°, and the latter is marked 212°, and the space between them is accurately divided into the parts between these two numbers; farther, thirty-two such parts are placed below the freezing point, and the lowest is marked 0, and is termed *Zero*. This mode of dividing the scale is that which was first employed by Fahrenheit, and hence it is called Fahrenheit's scale, which is universally used in Britain. All the degrees of heat which we shall mention in this work are according to this scale. On the Continent other scales are used, and a certain calculation is required to convert the degrees of these scales to that of Fahrenheit. It sometimes happens that degrees of cold are to be measured so intense as to freeze mercury, and to cause it to become solid; then a thermometer filled with spirits of wine must be employed, as this resists the most intense cold without freezing; and when degrees of heat are so high as to cause mercury to boil, no thermometer can be employed, and recourse must be had to an instrument called a *pyrometer*, the best of which consists of bars of some metal difficult of fusion, the expansion of which measures the heat.

CHAPTER II.

THE VARIOUS METHODS OF WARMING DOMESTIC BUILDINGS.

305. The various methods which have been put in practice for producing a proper temperature in the interior of our buildings may be reduced to the following: 1. Warming by fires burning in open chimney fireplaces. 2. By flues under the floors, or in the walls. 3. By close stoves of brick, earthenware, or metal, erected in the apartments. 4. By pipes kept full of steam. 5. By pipes full of hot water. 6. By streams of heated air sent into the apartments. 7. By combinations of these methods. We shall treat of these various modes separately, and we shall reserve our observations on their comparative advantages until we have given a description of each.

Sect. I.—Warming by Chimney Fireplaces.

306. Fires in open chimney fireplaces constituting the general method of warming apartments in Britain, it is necessary for those who wish to derive all the advantages which this method affords, to pay some attention to the subjects of combustion, of fuel, and the construction of chimneys.

Subsect. 1.—*Of Combustion.*

307. *The true nature of the combustion of fuel* was never understood until it was illustrated by modern chemistry: before that time, all reasoning respecting it was very erroneous, and often absurd. It is only by learning a few chemical principles that just ideas

can be entertained on this subject, and these are essential towards the proper management of artificial heat.

308. *All the fuel for making fires is, or has been originally, of a vegetable or animal nature*, and chiefly the former. We here refer the reader to that part of our work where we treat of the chemical analysis and composition of animal and vegetable substances, in Book VII., "On Food," and where the elementary principles of which they consist are particularly described: indeed, we consider it quite necessary that this should be studied before the subject of combustion be entered upon. But to save him some trouble, and to serve our present purpose, we shall here enumerate a few of the principal circumstances, which will be more fully explained afterward.

309. *All animal and vegetable substances (to which classes we have stated fuel belongs) are composed* of a few elementary ingredients: these are oxygen, hydrogen, carbon, and nitrogen; but the latter is seldom found in vegetables, though never wanting in animal substances. Wood, a very general fuel, is composed of oxygen, hydrogen, and carbon; and coal, which is of a vegetable origin, consists of the same principles, but having less oxygen than recent vegetables, and sometimes it has a little nitrogen. Two of these elements are easily conceived, the hydrogen and carbon; for the first of these is now familiar to us, as being a portion of what is called coal gas, and the last is the pure basis of charcoal; the oxygen will perhaps be better comprehended when we speak of atmospheric air. We trust the unscientific reader will not feel alarmed at this enumeration, since we can assure him that, however difficult it may be at first to follow us in the path we are tracing out, it will be found perfectly easy with a little patience.

310. *Air being absolutely necessary to the combustion of fuel*, we must likewise beg the reader's attention while we describe its nature. It is not known to half the world that the air which surrounds us is a substance, it being quite invisible, and appearing to afford no resistance to the touch of the common observer. But its invisibility is owing to its perfect transparency and want of colour; and we are immersed in this thin elastic fluid, as a fish is in clear water, which to him is, no doubt, equally invisible. That air is a substance can be shown by the apparatus called an air-pump, by which we can draw it out of a glass jar, and then its actual weight can be ascertained. It can be felt, likewise; since the hand, when moved very rapidly backward and forward through it, meets with the same kind of resistance, though in a less degree, that a stick does when moved through water. Wind is nothing more than a stream or rapid current of this invisible fluid.

The air of the atmosphere is not, as was once supposed, a simple body or element. It is now known to be composed essentially of two kinds of air or gas, united together; and modern chemistry has separated these from each other: it is likewise found that the properties of these two kinds are very different from each other, and also from the common air resulting from their combination. The names given to these gases, which form the constituents of atmospheric air, are *oxygen gas* and *nitrogen gas*.

311. *Oxygen gas* is that portion of the common air which conduces to the support of our life when we breathe; and hence it has also been named *vital air*. In respiration or breathing, we draw in air to our lungs, which separate it into the two constituent parts, retaining the oxogen, which then mixes with our blood, and enters into our system. It is this kind of air, likewise, which supports the combustion of a fire, which cannot burn without it any more than we could live without it.

312. *Nitrogen gas*, the other portion of atmospheric air, and which we throw out in breathing, has no action in the support of life or the combustion of fuel; on the contrary, if we were to breathe it by itself we should be suffocated, and a fire supplied with it would instantly be extinguished: hence we cannot breathe the same air over and over again.

Although we have said that common air is composed of oxygen gas and nitrogen gas, yet it always contains a very small portion of some other airs or gases, which we must mention as essential to our subject. Of these, carbonic acid gas is the most constantly present, and in the largest quantity, this being generally about one or two per cent.

313. *Carbonic acid gas* is composed of the element carbon, or the principle of charcoal, and of a portion of oxygen, both being chemically united; and it has a slight degree of acidity, whence its name. It is formed abundantly in nature in many instances: it is produced during the fermentation of malt liquors (for which see Book VIII., "Fermentation"), being the gas which always lies at the top of the fermenting vat, and which feels so sharp to the nose when snuffed up. It is likewise this gas which escapes when soda water or bottled porter is uncorked. Carbonic acid gas is, like all the gases, except oxygen, unfit for the support of life or combustion, and is therefore a suffocating gas; but the quantity existing in the air we usually breathe is not sufficient to be injurious to us; but, when in large proportions, it is very unhealthy. It is sufficient at present to observe, that it is abundantly produced by the burning of charcoal, and, indeed, of any other fuel. It is heavier than common air; hence, in some cases, it may abound in the lower part of an apartment, while the upper is nearly free from it.

314. *Hydrogen gas*, or inflammable air, is now pretty well known, being obtained from

coal, and burned for artificial light. It is, indeed, the cause of all the flame from coal or wood.

315. *Having now introduced the reader to an acquaintance with the composition of fuel and of air, we shall proceed to show in what manner each is affected by the process called combustion.* That a combustible body shall burn, it must be *kindled*; that is, it must be brought into contact with another substance actually burning, and thus be affected by heat.

As the simplest case, we will first consider the combustion of charcoal. When a portion of the charcoal is kindled or made red hot, the carbon decomposes the atmospheric air surrounding it, uniting to the oxygen, and thus forming carbonic acid gas, heat and light being given out in consequence of this process. If, therefore, charcoal be burned in an apartment without a chimney, the consequence will be the production of a large quantity of this suffocating gas, which, mixing with the common air of the place, may not at first prove fatal, but if suffered to accumulate in a great quantity, the room being close, will infallibly prove so, as is well known from persons dying in consequence of sleeping in a small room with a pan of lighted charcoal.

The combustion of wood or coal is more complicated, as they consist, not of carbon only, like charcoal, but of the three other principles, carbon, hydrogen, and oxygen. When a piece of wood is kindled, the heat causes these elementary principles to separate and become gaseous in the following manner: The hydrogen of the wood, united to a portion of carbon, forming a variety of carburetted hydrogen gas, or the gas that burns in gas light, joins rapidly to the oxygen; and this rapid union is productive of that heat and light which appear as flame: at the same time, a certain part of the hydrogen only, uniting to the oxygen, forms water, which becomes vapour or steam in this intense heat, and is dissipated or dissolved in the atmosphere. Of the remaining carbon or charcoal, a part joined to oxygen forms carbonic acid gas, which, being highly heated and expanded, and hence rendered specifically light, rises upward, and is mixed with a little pyroligneous or acetic acid, generated in the combustion, and which gives the penetrating effect peculiar to wood smoke, and which is not found in the smoke of coal. The rest of the carbon remains at first as charcoal; but this also burns, and finishes by being converted into carbonic acid, as in the case of charcoal above mentioned. From this we see that the wood in burning is decomposed, and separated into its elementary constituents, and likewise that several other substances are produced; for it is to be observed that nothing in nature is ever destroyed, the disappearance of any material by combustion being, in fact, merely a new arrangement of its parts in other forms. The new substances, in this case, are carbonic acid gas and water, or, rather, aqueous vapour; to which we must add nitrogen, for that is the remnant of the air, after the oxygen was taken from it, the nitrogen having no active part in the combustion. If wood, therefore, is made to burn in a room without a chimney, two deleterious gases will be produced, carbonic acid gas and nitrogen gas, the oxygen of the air being taken up to create the former; and if this combustion were to continue long enough, all the oxygen would be consumed, and only these two poisonous gases left, which are entirely incapable of supporting life. It is obvious, therefore, that to have much wood in a close room without a chimney would be as fatal to burn as charcoal. The same will be the case with respect to any other combustible; as, for instance, coal.

316. *Many persons are deceived from charcoal giving out no smoke*, and they are hence not sensible of the production of so poisonous a gas as carbonic acid, which is properly invisible; they often suppose, also, that it is the smoke alone that suffocates in the burning of wood in a close apartment; but the smoke, though disagreeable, is not the chief cause of the suffocation, which is owing to the production of the carbonic acid, a few inspirations only of which are fatal. Seeing this to be the case, that all combustion produces deadly poisons, this process would be fatal to us, were it not for a wise law of nature. The heat produced by combustion causes all these gases to expand and become specifically lighter than the common air, in consequence of which they rise upward, which prevents our breathing them, except they are suffered to accumulate in a confined space; and now appears the use of a chimney with its flue. When fuel is burned in one of them, all the deleterious gases ascend through it, and escape into the open air, without contaminating that of the apartment. The ascent of the smoke enables us to perceive this rising current; but the smoke itself is nothing more than a small portion of the fuel which has escaped the combustion, and is carried up by the ascending currents of the new gases so produced, and which we have described. It is, indeed, merely an extremely fine dust or powder, which, when collected, is the soot that attaches to the flue, a substance well known to be still inflammable. The smoke being visible, assists in estimating the rapidity of the ascent of the gases that rise from combustion, but is not itself so dangerous as the gas which carries it up; and, indeed, smoke is itself heavier than the atmospheric air, and falls down when separated from the heated air.

317. *The combustion of coal is very similar to that of wood*, the elementary constituents being nearly the same. The flame of both, as we have stated, is owing to the burning of the hydrogen, or, rather, the carburetted hydrogen or coal gas; as charcoal and coke have been both deprived of their hydrogen in the process of charring, they cannot, of

course, give any flame; neither can anthracite, a kind of natural coal having no hydrogen, but consisting, like coke or charcoal, almost entirely of carbon. The nature of the various kinds of fuel will be described afterward, in Chapter III.

318. *But besides the gases we have just mentioned, a very small quantity of sulphuretted hydrogen*, another suffocating gas, is given off by *the burning of coal*; some of the sulphur, of which all common coal contains a small portion, uniting with some of the hydrogen. A part of the carburetted hydrogen also escapes without having been burned, in consequence of being disengaged when there was not flame to reach it. All these rise into the atmosphere with the smoke from a chimney, and do not come into the apartment.

In this description of coal by combustion, we have supposed it to be perfectly pure; but as all coal contains more or less, likewise, of earthy matters not combustible, these remain, after the combustion is finished, in a state of ashes; of course, the more impure the coal, the more ashes will be left.

319. *We shall not here enter upon the inquiry, in what manner is the heat generated by the process of combustion?* as this remains one of the mysteries in nature's operations not yet thoroughly understood: it is sufficient to say that it is developed in consequence of the mutual action of the fuel and the air upon each other, by which the elements of each are separated, and made to assume new forms. Some have maintained that the heat is chiefly contained in the air in a latent state, and is set loose when combustion takes place. However that may be, the heat from combustion evidently appears in two states; one part is in the form of *radiant* heat, which we explained in the article "On Heat," and which is sent off in all directions from the burning body; this may be absorbed by the substances it strikes upon, or may be reflected from them. The other portion of the generated heat is *combined* with the newly-formed gases and vapours, which carry it with them upward. This last portion of the heat does not act like the radiant part, but may be communicated, by conduction, to those substances on which the heated gases strike, as in the case of the flue of a chimney, or a pipe through which the smoke rises, or is made to pass.

SUBSECT. 2.—*Construction of Chimney Fireplaces.*

320. *A chimney fireplace is a recess* in the wall *a*, *b*, *fig*. 53, for the fire with a flue over it, that reaches to the top of the house for the exit of the smoke. The sides of the recess are called the *jambs* of the chimney; and the top at the opening, or *mantel*, *c*, is generally covered by an iron bar with a flat arch over it, concealed by an ornamental chimney-piece. Just above this opening the funnel is contracted to the proper size of the flue, shown by the dotted line, and the contraction is called the *throat* of the chimney, *d*. The horizontal section of the flue is usually oblong, not less than fourteen inches by ten inches, to admit of the process of sweeping. Flues are also occasionally made cylindrical.

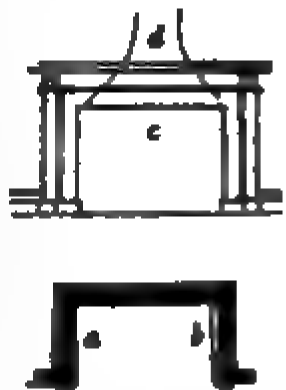


Fig. 53

321. *When wood and peat were the only kinds of fuel in use, chimneys were made very large*, and the wood was burned upon irons called *dogs* laid upon the hearth, a few of which may still be seen in old mansions. About fifty years ago, when coal had come into general use, grates for burning it in were universal; but though the chimneys were considerably contracted, the throats were still very wide, as appears at *e* in the section, and the jambs remained at right angles to the front, as shown in the plan *a*, *b*, the consequence of which was, that the smoke was frequently sent back into the apartment, and that intolerable nuisance, a smoky chimney, was very common; while a great part of the air that was just warmed by the fire made its escape through the wide throat, producing a proportional current of cold air towards the fireplace. In consequence of this, a person near the fire had one side heated and the other cooled; added to which, the fires were kept in the grates so high up from the floor, that the feet were always immersed in a stratum of cold air that covered the lower part of the room.

322. *In this state our chimney fireplaces were found by the celebrated Count Rumford*, to whom we are under infinite obligations for teaching the true principles upon which they ought to be constructed. Since that time, a great reformation has taken place in this part of our domestic economy, and our open fires are rendered far more effective in warming our apartments, and have become more comfortable and elegant, as well as more economical in point of fuel.

323. *The principal improvements effected by Count Rumford in our chimneys* are shown by the plan *g*, *fig*. 54, elevation *h*, and section *f*, of a chimney. 1. He brought the back of the fireplace farther forward into the room by building another brick back within the old chimney. 2. He placed the jambs inclined, as in the plan *g*, and elevation *h*, that they might reflect more heat into the room. 3. By bringing the grate forward, and raising the new back up above the mantel, the throat of the chimney was much contracted,

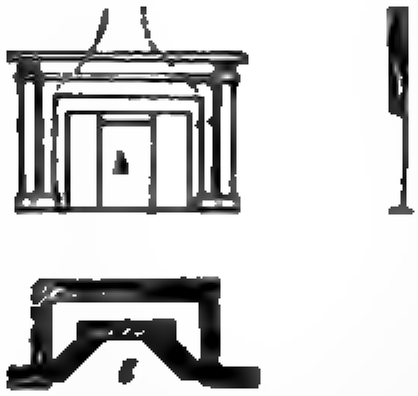


Fig. 94.

as in the section *f*; and to allow the chimney-sweeper to ascend the flue, an opening was left, closed up by a loose piece of stone, as shown in the section, which was taken down when the chimney was to be swept, but replaced when that was done: by this contrivance, the draught in the throat was very much increased, and by this simple means alone the greatest number of smoky chimneys were cured. 4. The bottom of the grate was considerably lowered, and brought down to within six or eight inches of the floor, by which the hearth and floor of the room were much more warmed. 5. By using as little iron as possible in grates, and fitting up their interior with fire-brick, they were made not only to throw out more heat into the room, but also to make better fires.

Thousands of old chimneys were altered according to these principles; the number of smoky chimneys cured all over the kingdom is scarcely conceivable; and much good, upon the whole, has resulted from these ideas having been, at least partially, adopted.

The jambs of chimneys are now almost universally *Rumfordised*, as it is termed; that is, made inclined when grates are set; and in the best fireplaces the fires are kept lower, as well as the mantels. The throats are frequently contracted, though seldom, if ever, completely in the *Rumford manner*. But one of the greatest improvements in fireplaces, namely, making the fire burn against brick or stone instead of iron, is that which is most neglected.

Although some mechanics were at first instructed in the principles upon which Rumford fireplaces should be executed, yet, from the opposing interests of trade, and the almost total absence of scientific knowledge in that class of persons on whom their construction usually devolves, these lessons have been long ago almost entirely forgotten. Since the time when Count Rumford left this country, new generations have grown up, a large proportion of whom are unacquainted with his merits, and almost with the very name of Rumford.

The limits and nature of this work will not admit of our going into all the details respecting chimneys, necessary to be understood by the bricklayer and other mechanics, in constructing and altering them so as to cure all their defects; but we shall lay down their leading principles.

324. *In investigating the best form of a chimney fireplace, it is necessary to keep in view that the objects to be attained are*, that the room should be warmed as completely as possible, and in such a manner that the air may be preserved perfectly pure and fit for respiration, free from smoke and all disagreeable effluvia, and this with the greatest economy of fuel.

325. *It may, perhaps, at first seem superfluous to inquire in what way an open fire warms a room*; but a more careful consideration of the matter will show that it is highly deserving of the most attentive examination. Here we must refer the reader to what we have already stated in the article "Heat," as to the manner in which it is *propagated*, by radiation, reflection, and conduction. Rays of heat are projected in all directions from the fire; but the rays which are directly radiated have no effect in warming the air through which they pass, on account of its transparency, as has been already shown; and it is only when the rays impinge against, or strike upon, a solid substance, that they produce any effect. In this manner, then, projected rays warm the floor and sides of the apartment, and the various articles of furniture; and these, having first absorbed the heat, give it out again to that portion of the air in contact with them. It is of the first importance to understand this fact, that it is not the air which warms the room in the case of an open fire, but the room that warms the air. It is true that the grate itself, becoming very hot, must heat the air in immediate contact with it; but this heated air, rising immediately, goes almost all up the chimney, and is therefore nearly lost to the room. The iron likewise projects radiant heat; but this is in too small a quantity to have any effect worth mentioning. Besides the heat that proceeds in a radiant form immediately from the fire, another portion of heat is reflected from the back and sides of the grate, and also from the jambs or sides of the chimney. With respect to what is reflected from the inside of the grate, here the importance of brick or stone is shown; for those materials, being nonconductors, do not absorb so much heat as iron (a conductor) does; therefore they throw it off; and when they become red hot, they radiate much heat; and this is the reason why they are preferable to iron, the latter material absorbing much, and seldom becoming so hot as to radiate in proportion.

326. *The inclined jambs or covings of Count Rumford* likewise reflect more heat into the room than those formerly used, which were at right angles to the front; and they assist also in preventing smoke. The proper angle is 130° with the back. They should always be flat: curved covings, which we sometimes see, were condemned by Count Rumford, as occasioning eddies that often cause smoke to come into the room.

327. *The importance of keeping the fire as low as possible* must be obvious, when it

is considered that air expands by heat, and then becomes specifically lighter: now, whatever part is made lighter than the rest, will rise upward, as oil will rise in water. Hence the lightest and warmest air is always at the top or ceiling of the room, and the coldest upon the floor. Whatever, therefore, will warm the floor most, will have most effect in warming the air of the apartment. Keeping the fire low must have this effect more than if it is higher, since the radiant heat must strike most upon the floor; and the difference is very remarkable in the warmth which our feet experience whether the fire be low or high up. Keeping the mantel low in proportion is, likewise, useful for warmth; for the air *below* the level of the mantel is liable to go off into the chimney, and be carried up the flue; but whatever is above the mantel cannot escape. It is evidently desirable that no air shall go up the flue, except what has been rendered unfit for breathing, by passing through the fire and serving the purpose of combustion. This we might do by shutting up the whole front of the chimney except the place where the bars of the grate are: but we should thus convert the grate into a furnace, and the draught would be too strong; the fuel would be rapidly consumed, and the rush of air towards the fire would be in proportion.

328. *The width of the throat of the chimney has a great influence*, both on the draught and on the escape of warm air. For as no fire can burn without air, and as there must be always a quantity going up the flue, just in proportion to the combustion, when the throat is narrow the current must be more rapid than when it is wider, just as the current of a river will become more rapid in the part where the width of it is suddenly contracted: hence the reason why contracting the throat, by making the ascending current of air in that spot more powerful, enables it to overcome any downward puffs that would occasion smoke.

329. *The proper height of the mantel above the fire* is an affair of nice adjustment; for if it be too low, it will cause the current of air towards the fire to be too rapid, and the fire will burn away too fast without giving out much heat; and if it be too high, the current may be too little in the throat, and much of the warm air of the room will escape. No rule can be laid down for this that will suit all cases: much will depend upon the particular form of the grate, and it must be determined by the skill of the person who directs the work. In the best grates now made with frames, this height is generally well adjusted.

330. *Although the farther out the back of the grate is brought, the more heat will be thrown into the room, yet this should be limited* by the proper construction of the throat of the chimney; and bringing it too forward is liable, in many cases, also to occasion smoke as well as the annoyance of ashes.

331. *A small flue for carrying off the dust made by the ashes which fall from the grate* was one of those numerous little inventions made by Count Rumford, which, though ingenious, and promising at first to be useful, was laid aside after repeated trials; and it would not now be mentioned, had it not lately been published as a novelty, although it had been executed in England in hundreds of places thirty-five years ago. It is obvious, that whenever any ashes fall from the fire upon the hearth, particularly when the fire is stirred, a certain portion of them, from their lightness, rises in a little cloud, and is dispersed through the air of the apartment, settling at last upon the furniture. To obviate this inconvenience, the count made a small flue to ascend from below the bottom of the grate, passing behind the back of the fireplace, and terminating in the smoke flue just above the throat. The air in this little flue being heated by the fire, a current is always set up through it from the back of the hearth, so that when any ashes fell they were carried sharply under the grate and up this flue, instead of coming into the room. This certainly had the desired effect in a great measure; but several inconveniences attended the contrivance. Its construction required great depth in the chimney, which was not always sufficient without bringing the grate too far forward. The ash-flue was very liable to be choked up by soot falling from the smoke-flue, and this soot was very liable to be inflamed, and set the chimney on fire, being, at the same time, rather troublesome to clean out; also, this flue occasioning a current of air to pass up, it was supplied by the cold air rushing towards the fire; and it thus increased sensibly one of the greatest inconveniences of an open fire, the current of cold air striking upon our legs and feet. It was chiefly useful when, as formerly, the bottom of the grates had been kept at a great height above the hearth; but, since grates have been kept low, the necessity of this ash-flue has disappeared.

SUBSECT. 3.—*On Grates.*

332. *The grate has become an essential part of our chimney fireplaces*, since coal has been the general fuel; but the forms of these now made are so various, that it would be impossible to describe all in a work like the present; nor would it be useful to give many examples, since every manufacturer has his own patterns, which are, therefore, now almost as numerous as those of the calico printer. It will be more useful to lay down some principles by which the choice may be directed in the show-room. We must therefore refer the reader to all that we have said on the essential improvements by Count Rumford, which must form the foundation of good rules.

333. *The register stove, fig.* 55, which was much in use about forty years ago, was considered as a great improvement upon the open chimney before its introduction. This grate was not invented by Count Rumford, as has been erroneously stated by a late popular author; on the contrary, he considered it as extremely faulty as it was then executed. Its name was derived from a movable plate of iron a little way above the fire, by which the draught could be regulated, and which could be shut down altogether in summer to keep out the soot or dust. These grates were frequently got up in an expensive style, with much polished steel and other ornaments. They had the effect of preventing smoke, but with the inconvenience of throwing out little heat in proportion to the fuel which they consumed. We have already described the principal improvements made by Count Rumford in our chimney fireplaces; and several small grates were cast and put up under his direction. But he was not a manufacturer; and though he gave to the public, in his "Essays," the philosophical principles on which they should be constructed, he left it to the manufacturers to invent beautiful forms; and had the first been as well understood as the latter, we should have reason to be better satisfied.

334. *The best of our modern grates are combinations* of the old register stove and the Rumford improvements. They have always an ornamented frame to fit the inside of the marble chimney-piece, and a register in the throat. The fire is brought low, or near to the hearth. But the fenders are frequently made preposterously high, which stops much of the heat from that part of the floor where it would be the most useful.

335. *It was a doctrine first taught by Count Rumford, that the great quantity of iron usually put into grates* abstracts much more heat from the fire than it can give out to the apartment, and therefore occasioning a loss of heat, and, consequently, a waste of fuel. This is certainly quite *true in principle;* and it is by reference to principles that the merits of inventions or constructions are to be determined. But it must, in candour, be admitted, that in our houses we have other circumstances to consider besides economy, or even the most effective sort of fire. A great attention to elegance in furniture is now the order of the day: this is considerably influenced by the nature of materials; and many persons will give up something of economy for the sake of appearance. Here is, therefore, another principle involved besides the saving of fuel. Besides, what would be extremely proper for a person of small income, might not be suitable for the drawing-room of a person of fortune; even in the houses of the latter class, fireplaces for the various apartments require to be fitted up on principles suited to their situations. Various materials are used in our best grates, cast iron, wrought iron, polished steel, brass, and bronze; and several of these are often happily combined. Iron has undoubtedly many bad qualities when used in great quantity about a fire; and, were economical principles alone considered, the less of it employed in a grate the better. But it can easily be cast in a great variety of ornamental forms; and it has the advantage of great neatness and durability, qualities which generally weigh against everything that can be said against it. Brick or stone cheeks in the grate are by much the best for the fire to burn against; and those who are anxious to have the best possible open fires, we advise to have them. But the ironmongers abhor them; very few will keep them; and still fewer recommend them. Hence they are difficult to procure; and to adapt them to grates, is expensive on this account; nor are they so durable as iron. Replacing them when they crack and burn out is attended with trouble; and most persons will rather waste a few coals with grates having iron sides, than follow advice which few understand.

Besides the great trouble of keeping polished steel in good order, there is an objection to having much of it in a grate, founded on a physical principle discovered by the late Professor Leslie, which is, that bright, polished metallic surfaces, though they reflect heat well, throw it off by radiation very imperfectly; but, if the same surface be rendered dull or rough, the radiation is immediately augmented. According to this principle, it has become a practice to grind flat with emery certain parts of the surfaces of the best grates, and to leave them in that unpolished state.

336. *Improved register grates of Rumford forms, with frames,* are also now made entirely of cast iron at very reasonable prices.

The smaller grates, called *Bath stoves,* the *hobs* of which are so convenient, are too well known to require illustration, and though wholly of iron, are yet useful from their cheapness and portability.

Upon the whole, though excellent fires may be made in some of the best grates now to be seen in the show-rooms of the ironmongers, yet we are much afraid that the prevailing rage for novelty, causing good models to be laid aside which have been improving for years, may occasion new forms to be attempted without sufficient knowledge of principles. We are led to make these remarks from the disappearance of many grates of excellent construction and good taste, to make way for others loaded with the now fashionable ornaments of the time of Louis XIV. It should never be forgotten that the real use of a fire grate is to warm the room; and if it fails much in this essential, the deficiency will be ill compensated by any other quality, which ought to be subordinate to the main object.

337. In common language, the necessary distinction between a *fire grate* and a *stove* is often not properly attended to. Hence a confusion of ideas: thus, a sort of common grate is called a *Bath stove*, and we sometimes hear of *register stoves*. The system should be, *not to call any contrivance a stove*, except where the fire is concealed, either always or occasionally; or, rather, where the heat is chiefly given out by the heated apparatus only, not depending upon the radiation from the fire, as in a common open grate.

338. *Out of the almost infinite variety of forms of grates that have been made at various times, we have selected a few of those which are most in use.* Grates of this kind are sold by the ironmongers, who keep large collections of various patterns in their show-rooms; and there are so many in London who have them nearly of the same quality, that it would seem invidious to recommend any in particular.

339. *Fig.* 55 *is the register grate* as it was when Count Rumford found it, and which has been mentioned already. It is not made at present in this form, and is only to be seen in old houses. The sides were not inclined, but at right angles to the front. The fire was about sixteen or eighteen inches from the floor; and the distance between the top bar and the bottom of the frame very small, so as to cause a rapid draught up the chimney. These grates, therefore, though they made a bright fire, gave out little warmth to the apartment.

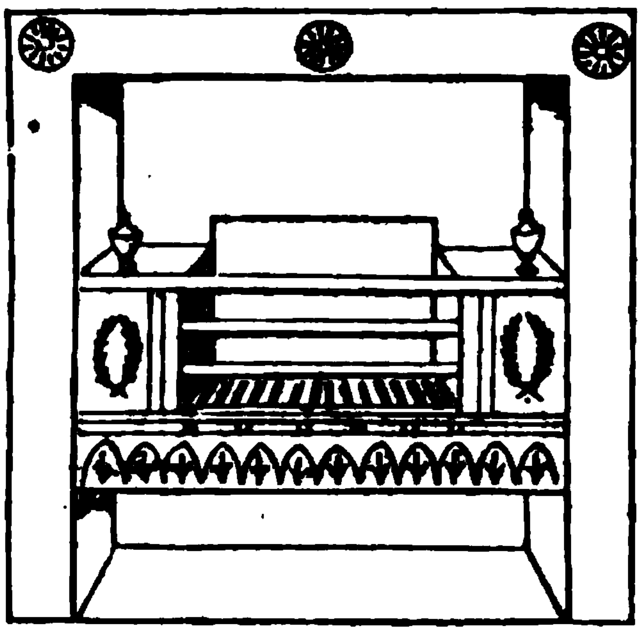


Fig. 55.

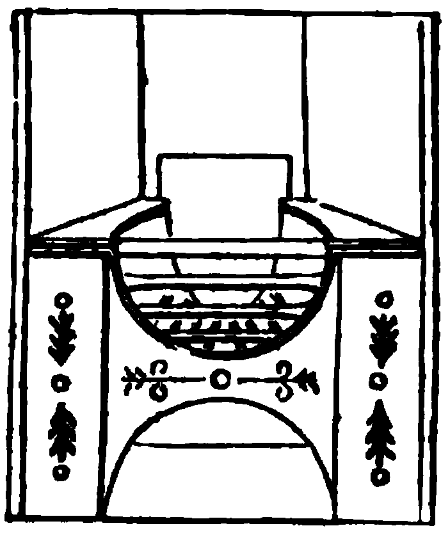


Fig. 56.

340. *Fig.* 56 is the well-known *Bath* stove or grate, but with the jambs Rumfordized, that is, with the covings of the chimney placed at the angle recommended by Count Rumford, instead of their being at right angles to the front, as they were formerly. This necessarily reduces the hobs, and therefore renders them less convenient for such persons as find them useful in cooking: but this construction economizes fuel by throwing out more heat by reflection, and still more by preventing the escape of much warm air of the apartment; and it tends to prevent smoke by narrowing the throat of the chimney.

341. *Fig.* 57 *is one of the simplest of the Rumford grates*, proper for an office or bed-chamber; the covings are placed at an angle of 135 degrees with the back, and made of stone, with the exception of the part where the fire burns against it, below the dotted line, which is of fire-brick; in fact, there is merely an iron bottom and front attached to sides of stone and brick. Some ironmongers, however, have made the whole covings of iron, which is only to be excused on the score of durability, iron throwing out much less heat than nonconducting materials. It is to be observed, that in this grate the fire is very low, within a few inches of the hearth; whereas formerly, as we stated above, the bottom of the fire was kept up generally eighteen inches; and it was not uncommon for bricklayers to raise up the grates by putting a brick or two below them, from an idea that the fire would not burn well if it was low.

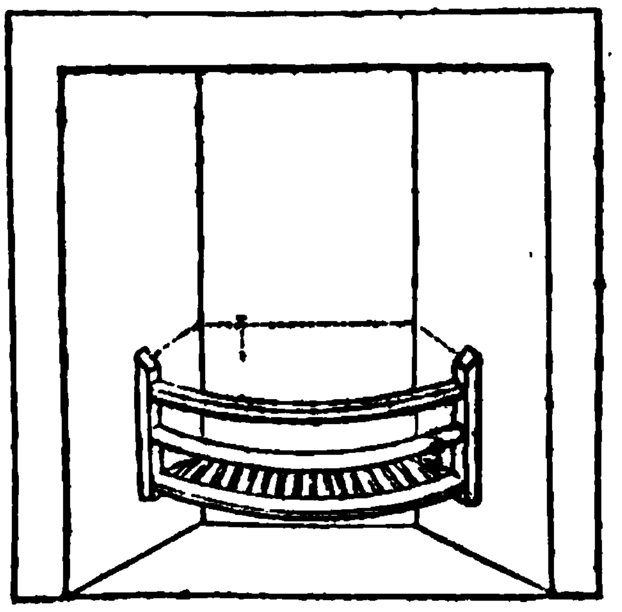


Fig. 57.

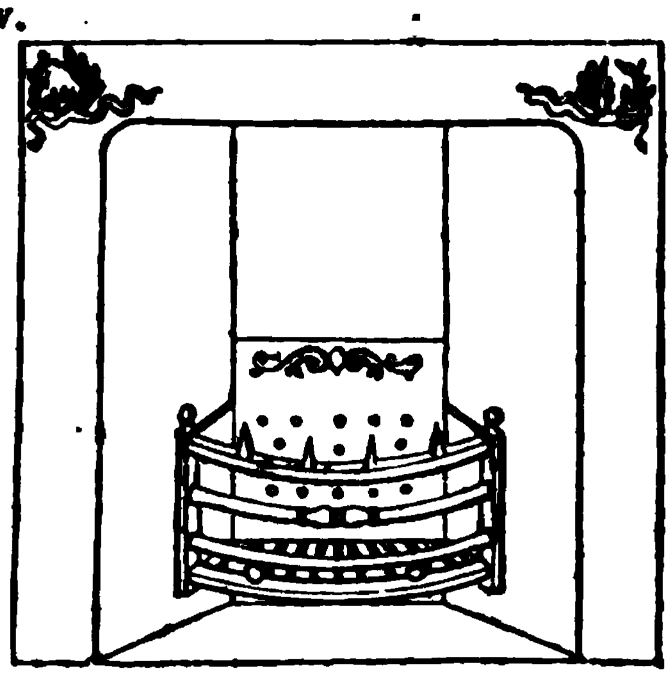


Fig. 58.

342. *Fig.* 58 is a grate of the same general construction, but *ornamented*, and *proper for a sitting-room*; it is generally made wholly of iron, the front ground flat, with brass ornaments laid on.

343. *Fig.* 59 is another still more ornamented in the style of the time of Louis XIV The iron front and covings are ground flat, and not polished, and the ornaments are of brass or bronze.

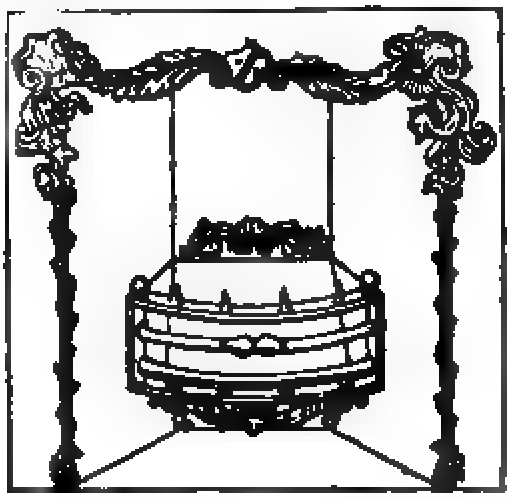


Fig. 59.

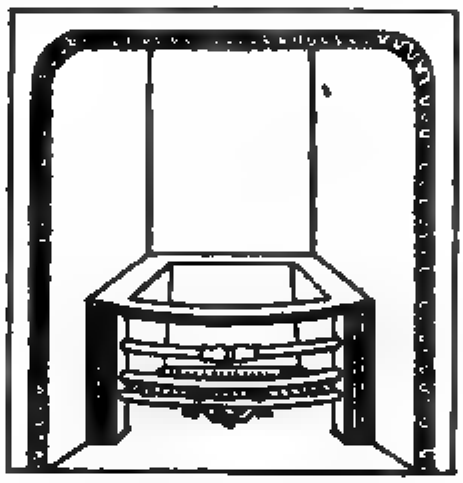


Fig. 60.

344. *Fig.* 60 is a *Rumford grate*, the sides and back of which are of artificial stone, made to stand the fire; the covings of the chimney are first executed with the proper angle; and the grate, being moveable, is simply put into its place, and may be removed when required. There are several advantages attending this arrangement.

345. *Figs.* 61 and 62 are *two of the numerous grates to be seen in the show-rooms of iron-mongers*: the ornaments are in the gorgeous style of the time of Louis XIV , and sometimes of brass. This choice being a matter of taste and fashion, we avoid making any remarks upon it, except that the quantity of metal employed has more than one disadvantage.

Fig. 61.

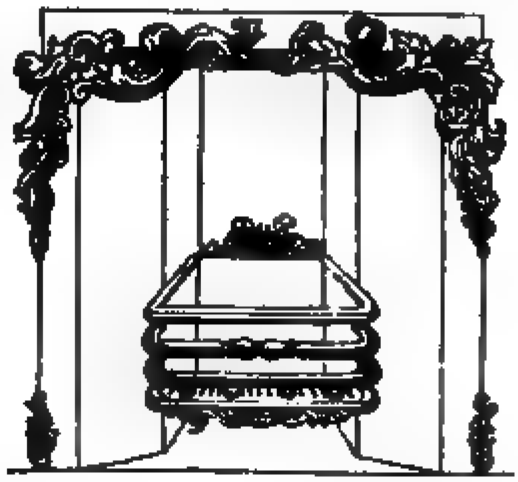


Fig. 62.

346. *Fenders and fire-irons* have varied in fashion, partly with the style of the grates, but more with the improvement of our manufactures. Some of the oldest fenders were made of iron and brass, plain, but with mouldings, and very low, to correspond with the wood fires on the dogs. Since coal burned in grates has been in use, they have been made higher, and are of an infinite variety of patterns. The cheapest fenders have been of tin plate painted, of wire painted, and with iron or brass tops and bottoms, and which are still used for bedrooms. A more durable kind has been cut out of sheet iron, and painted in imitation of iron wire. As iron fenders stain the marble they are placed upon, it is now the custom to raise them in front on a kind of pedestal, which slopes to the inside, and the front is supported by claw feet, knobs, or pieces of ornamental foliage, &c. At present the best and most elegant fenders are made of polished steel, enriched with brass or bronze, to correspond to the style of the grates; and a great many are of cast iron very highly decorated and ornamental. Fenders should not be higher than safety requires, as they thus stop much of the radiant heat of the fire, and that where it is most wanted, namely, in the lower part of the room, and keep it from the feet: to prevent this, they are always made with some open work. To the fender is usually attached holders for the fire-irons.

SECT. II.—WARMING BY CLOSE STOVES.

347. Close stoves are enclosures of brick, earthenware, or metal, which contain a

fire that heats the stove, and by means of that, the air of the apartment in which it is placed.

348. *Stoves differ essentially from open fires in their manner of warming.* We stated that open fires act chiefly by giving out radiant heat; on the contrary, there is comparatively little radiant heat from a close stove of any kind: the radiant heat of the fire within the stove is absorbed by the material of which the stove is made, and the latter warms the air of the room in contact with it. This warmed air rises upward toward the ceiling, and is succeeded by fresh air to be warmed in its turn, and so on, until the whole of the air in the apartment has received an increase of temperature. It is evident, therefore, that a stove warms the air upon the same principle as that by which water is heated in a vessel over a fire.

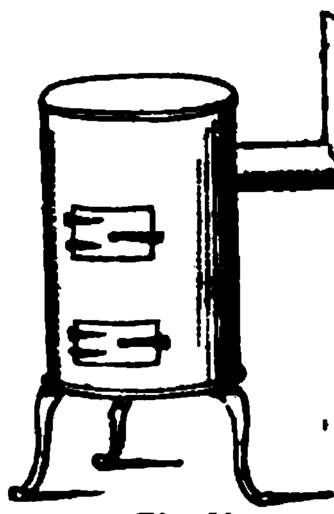


Fig. 68.

349. *The common German stove*, or, more properly, the *Dutch stove*, used in this country, is as economical and effectual as any stove whatever, for warming an apartment; and were not its use attended with serious disadvantages, it might be much employed. It consists merely of a cylinder of sheet iron, *fig.* 68, furnished with a grate in the interior for the fuel, a door for the fire, and another for the ashes, with a pipe to carry off the smoke into the chimney flue, which pipe may be lengthened when much heat is required. Here no air passes up through the chimney except that which has come through the fire, and has served for the purpose of combustion, being rendered unfit for respiration; and the whole of this is carried off. All the rest of the heat, over and above what thus passes off with the smoke, is communicated to the iron, and by that to the air of the room in contact with it, at the same time that a good deal of heat in a radiated form proceeds from the iron itself, when much heated. As this stove may be placed at a distance from the wall by lengthening the pipe, it is very effectual in producing a great deal of heat, while it occasions no disagreeable draughts, no smoke, and no dust. But the inconveniences are, that there being no regulator for the draught of the air, the iron is apt to become red hot, and then it is extremely dangerous if placed near anything combustible; and as the fire is not seen except when the door is opened, it is difficult to regulate it. But another circumstance which renders its use inconvenient is, that the iron being generally much heated, a disagreeable effect is produced upon the air of the apartment, which is variously described, and has never been satisfactorily accounted for. The air is said to acquire a *scorched*, a *burned*, a *close*, or a *sulphureous* smell, and is very apt to produce headaches, giddiness, and even stupor, loss of appetite, ophthalmia, &c. The erroneous or vague nature of the description shows how little the effect is understood. The term *burned* is *improper*, for it is not known that pure air, simply heated to any degree, is altered in its quality. What is usually termed burned air is that produced by *actual combustion*, as has been previously explained. But in this stove none of these deleterious gases come into the room. The term sulphureous is equally improper, as sulphur can scarcely in any way be concerned with the effect. But whatever may be the cause, or whatever ought to be the description, all persons in this country agree that air so heated has acquired some property which renders it both unpleasant and unwholesome. Count Rumford imagined that the hot iron roasted the dust which settled upon it: and as the dust of a room is made up of all sorts of animal and vegetable matters, these, when burned, give out a disagreeable effluviæ. Others have attributed the effect, in a great measure, to the great dryness of the air so produced, resembling the African simoon, which they have endeavoured to correct by placing a small pan of water on the stove, the evaporation affording the necessary moisture to the air; others, again, have supposed that the effect is owing to some alteration of the electrical state of the air; and it has been absurdly imagined that the iron deprived the air of its oxygen. Whatever may be the true explanation of the effect complained of, and, possibly, all those just mentioned may combine, it is now universally allowed that the air is rendered disagreeable and unhealthy when it is warmed by iron heated much above the point of boiling water: hence the use of this and other iron stoves should be restricted to purposes where heat and dryness are required, but where the salubrity of the air is less important; for such uses, nothing can be more economical.

Many stoves of this kind, of cast iron, and of elegant and ornamental forms, are to be found in our halls and staircases, where it was thought the bad effect upon the air was less material, fresh air being more frequently introduced by the opening of doors. But it should be remembered that the air from these places extends all through the house, and must find its way into the best apartments. We may observe, that the draught might easily be regulated by a register to the ash pit, and a damper in the flue, though these are not usually made. The part where the fire burns might likewise be lined with brick, to prevent its getting red hot, which would lessen considerably the danger and inconvenience of this apparatus. But, from our experience of the effects of heated iron upon air, we are not admirers of iron stoves of any kind, where health is required to be much attended to.

350. *It is said that when iron is not heated above 212° it has no injurious effect upon the air.* This is not improbable; but as no series of accurate experiments or observations have been made and published to determine this important question, we think it best to leave it in its present state. There is little doubt, however, that iron heated to a small degree is less hurtful than when heated highly; but then, likewise, the heating power of the apparatus is diminished.

351. *It does not appear that close stoves, made of brick or earthenware, have the same species of injurious effects upon the air of an apartment as iron;* and stoves of these materials are much used in various parts of the continent of Europe. In Russia, and many parts of Germany, brick stoves are universal; they are generally made to project in the room somewhat like a chest of drawers, cabinet, or sideboard, and the door for the fire is sometimes in an adjoining room. Wood is kindled in them; and when this has burned so far that the smoke has ceased, and the brickwork is heated, the damper in the flue and register of the ash-pit are nearly closed, so that the combustion of the remaining charcoal goes on extremely slow, and the heat of the stove is retained during the day. In the severe climate of the north of Europe no other method would render the houses sufficiently warm; necessity, therefore, obliges the inhabitants to adopt this mode, in spite of any disadvantages it may possess. In all countries, also, when fuel is very expensive, the most economical means of using it have been resorted to, though sometimes not the most desirable on the score of health. In France, where open chimneys are likewise much used, stoves are employed through economy; but they are generally made of earthy materials, as brick, tiles, and ornamental earthenware, and are therefore not liable to the same objection as iron. In this country, it is remarkable that stoves of brick and earthenware have been seldom tried; and we have been contented with open fires, which certainly consume much fuel; or we have manufactured stoves only of iron, a material which we have in such abundance.

352. *Although close stoves certainly afford the most economical means with respect to fuel, as well as the most effectual way of warming the interior of dwellings, yet they are liable to this serious objection,* that with them it is difficult to change the air in apartments, or, in other words, to *procure that ventilation so essential to health.* When the door of the fire is in another room, and the windows and doors of the apartment made tight, as is found necessary in very cold countries, there can be very little change of the air in the room, and, consequently, the inhabitants must live in an atmosphere vitiated by a mixture of the portion that has been exhaled. This evil, perhaps, great as it is, may not in these countries be so great as that of excessive cold; but that it is an evil, it requires but a little knowledge of the subject of physiology to be convinced of. In countries where the climate is more temperate and fuel more abundant, and where, of course, the inhabitants are not compelled to resort to so unhealthy a mode, it does not appear judicious to employ it, except the means of perfect ventilation can be likewise provided. But this is by no means easy with close stoves, for even when the door of the fireplace is in the apartment, and, of course, the supply of air to the fire is taken from that in the room, and replaced by fresh air from without by some method or other; yet this is in general no more than the fire itself requires, and does not make up for what is also destroyed by respiration. With a close stove, therefore, whatever may be the construction of it, there is usually an accumulation in the apartment, more or less, according to circumstances, of gases and effluvia unwholesome to breathe. With respect to the best modes of getting rid of these as much as possible, we refer the reader to Book III., "On Ventilation." We may just observe in this place, that the foul air, which, being warmest, is at the top of the room, may in general be made to escape by keeping the upper sash open an inch or two. But this will not act except the ingress of as much cold air be provided for somewhere at the lower part of the room: if this be not done, the air will come in at the top sash, to supply the stove, instead of going out. The chief difficulty here is to contrive the ingress of cold air so that it may not incommode. This is best effected, perhaps, by numerous small apertures in places where they will be least inconvenient, and by preventing the stream of air from coming in directly, but turning it aside by some methods which must vary according to circumstances.

353. It would be unnecessary to inform those who have read with attention what we have said on heat and combustion, namely, that *all stoves which profess to heat apartments without a flue, must be in the highest degree pernicious, and even dangerous;* since it is quite impossible that combustion can go on without generating noxious gases, a circumstance well known to every one who has the slightest acquaintance with chemical science. No method has ever been discovered, nor is likely to be found out, of preventing this pernicious effect; and the consequence of putting a stove of any kind into an apartment without a flue to carry off these deleterious gases, whether the stove be fed with common charcoal, with charcoal prepared in any known way whatever, or with gas of any kind, will inevitably be, that the air of the room will become contaminated with invisible effluvia destructive to health, and sometimes suddenly fatal. This is so certain, that we trust no one will ever permit himself to believe that discoveries are made of modes of combustion without the production of poisonous gases. We might connect these ob-

servations with a description of *Joyce's stove*, which warms an apartment without a flue to carry off the fumes of the charcoal burned in it; but except the public shall become instructed in so much science as to be able to judge for itself on this subject, no pointing out of individuals will be of much avail, since one quack, impostor, or ignorant mechanic, will be succeeded by another. It is on this account we are desirous that the study of principles should be attended to, intead of mere receipts.

264. *Iron stoves are frequently made with flues to descend below the level of the floor*, for the purpose of getting rid of the smoke without the inconvenience of a pipe crossing the apartment. they are extremely useful in warming shops and other places where there is a considerable circulation of air, and where the effects of heated air are not perceived so much as in confined places.

A, *fig*. 64, may be supposed to be any hollow figure of cast iron. There is a partition in the middle that does not reach quite to the top, and in one of the divisions is the fire-grate *a*, fire-door *b*, and ash-pit, with its door, *d*. When the fire is lighted, and the fire-door shut, the smoke first rises to the top; but, finding no outlet, it is impelled, by the pressure of the air that feeds the fire, to descend through the other division, and to pass along the horizontal flue *e* to the main flue *f*, which carries it to the top into the atmosphere. This principle being kept in view, the forms may be varied *ad infinitum*, and some are made extremely elegant. It should be observed, that when good fires are kept every day in these stoves with descending flues, the heat retained in the chimney, causing a slight current even in the morning before the fires are lighted, will determine the proper course of the smoke, but in other cases it is rather troublesome to make it descend at first; but once the flues are warmed, the draught goes on perfectly well.

Fig. 65.

265. *The air stove*, which, some time ago, was very common in our shops, but which has now very generally given way to the *Arnott* and *other stoves*, is represented in *fig*. 65. It was one of the first improvements upon the common iron German stove. Besides the simple iron fire-chamber, there was also an external casting of iron surrounding that at the distance of two or three inches; by which construction, however much the fire-chamber might be heated, even if it were made red hot, the same degree of heat would not be communicated to the external casing, on account of the space between being filled with air. This stove is, therefore, much less dangerous, on account of fire, than the common German stove. The lower part of the space between the two casings is left open, by which the cold air enters below and gets heated between the two iron cases, and issues out at the top through a perforated regulator. The defects of this stove are, that the air may still be overheated, by using much fire, and that the warm air comes out only at the top of the stove, a considerable way above the floor.

Fig 66 is *another air stove* of similar construction, only the fire is lined with brick or fire stone, which prevents the air being overheated, and the warmed air comes out through the grating on the sides. A sliding plate at the upper part of the opening acts as an occasional blower

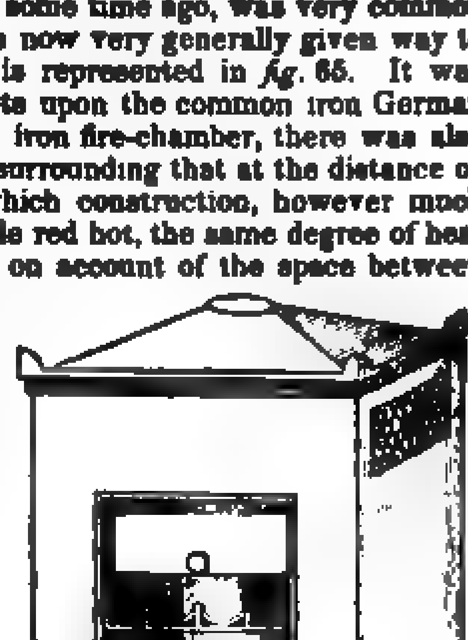


Fig. 66.

266. *The Pennsylvania* or *Franklin stove*, *figs*. 67, 68, is evidently borrowed, as to its principle, from a fire-place described in a book entitled "Mechanique de Feu," published in 1713. It is well adapted for heating an apartment, and at the same time affording a view of the fire; but being entirely made of iron, it has the usual defect of all the stoves made of this metal, in producing an unpleasant effect upon the air of the room. It was originally intended only for burning wood; lately, however, they have in America constructed it for burning coal. *Fig*. 67 is a view of the stove placed in the chimney, and *fig*. 68 is a vertical section. The fire, *a*, is made upon the iron hearth, and is partly enclosed between iron cheeks. The smoke, after rising up to the top of the stove, turns under the cover, and goes down at *b*, *fig*. 68, descending as low as the hearth to *c*, whence it passes upward into the main flue, *d*. The partition *e* is built up in the chimney, and the throat is closed by an iron plate, *f*, so that no air from the room can go out that way. The whole of the stove being of iron, is much heated by the fire, and communicates its heat to the surrounding air as

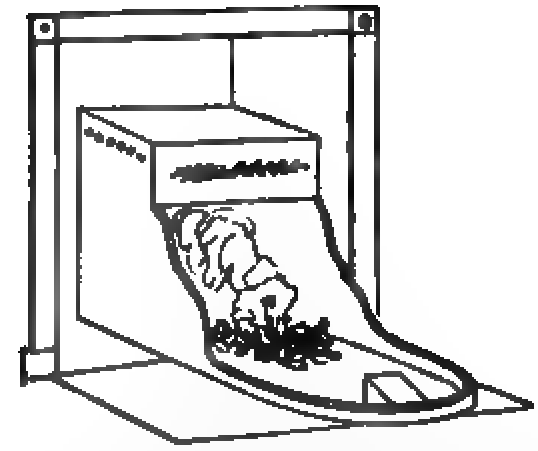


Fig. 67.

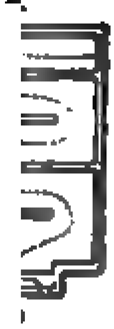


Fig. 68.

in a common German stove. But it likewise throws into the room a stream of air brought from without and warmed. This is effected in the following manner: The back of the stove, against which the smoke rises, is hollow, and contains partitions in the manner shown at A, *fig.* 68, which represents the hollow back with the front plate removed. The cold air from without enters through a flue at *b* (*see* section), passes beneath the hearth, *c*, and thence into the chambers at the back of the fire, seen in the section at *b* and at A. After winding through these chambers in the direction of the dotted line in A, it becomes heated, and issues through apertures in the sides near the top of the stove seen in *fig.* 67, but the throat of the chimney being closed, as at *f*, it comes into the room. The method of blowing the fire is by an opening in the iron hearth in front of the fire, partly covered by a little inclined plane, *k*, which directs the current of air that rises through it, against the fire. The fire is, therefore, partly fed by this air, and does not abstract so much from the apartment as would be the case were it wanting; it also reduces in the same proportion the usual current which makes towards the fire in ordinary grates. This stove is evidently not well adapted for the purposes of English cookery, and the inelegance of its appearance entirely unfits it for our best apartments, consequently it is not adopted in this country. A few have been tried in farmhouses, but it is inferior to other constructions.

357 *The American* or *Nott's stove*, *fig.* 69, is more remarkable for the novelty of its appearance than for any important advantage. The fire is contained in the pedestal, which is lined with fire-brick. The bottom of the grate is semi-cylindrical, and, being revolvable on an axis, is intended, by a rocking motion performed by a winch at the side, to shake out the ashes, or to empty the grate altogether into the ash-pit. The coals are put in at the top of the column, lying over the fire after it is kindled, and sink down as they are consumed, enough being put in at once to serve the whole day. To afford a view, or rather a peep, at the fire, a piece of mica (erroneously called *talc*) is inserted in the front, that substance not being liable to crack with the heat like glass. Many of these have been put in shops and similar places where there is a free circulation of air, and where they have rather an elegant appearance; but they have the usual faults of iron stoves, from becoming much heated.

358. *Dr Arnott's stove*, *fig* 70, though constructed of iron, is said by the inventor to be much less injurious to the air than iron stoves generally are, because the metal is never made very hot, there being an internal brick chamber to contain the fire, and the combustion of the fuel going on very slowly.

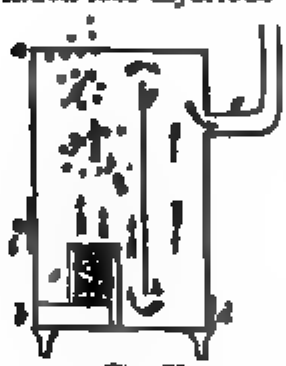


Fig. 70.

The following is the description by Dr. Arnott in his own words: "The outline section, *a*, *b*, *d*, *c*, represents a box formed of sheet iron, and divided by the partition *g h* into two chambers, communicating freely at the top and bottom. The letter *e* marks the fire-box or furnace, formed of iron lined with fire-brick, and resting on a close ash-pit, of which *b* marks the door, and near which door there is a valved opening, by which the air enters to feed the fire when the door is shut; *i* marks the door of the stove, by which the fuel is introduced: *c* is the chimney-flue. While the stove-door and ash-pit are open, a fire may be lighted, and will burn in the fire-box just as in a common grate, and the smoke will rise and pass away by the chimney, mixed with much colder air rushing in by the stove-door: but if the stove-

door and ash-pit door be closed, and only as much air is admitted by the valved opening in the ash-pit as will just feed the combustion, only a small corresponding quantity of air can pass away by the chimney, and the whole box will soon be full of the hot air or smoke from the fire circulating in it, and rendering it everywhere of as uniform temperature as if it were full of hot water. This circulation takes place, because the air in the front chamber around the fire-box, and which receives as a mixture the red-hot air issuing from the fire, is hotter, and therefore specifically lighter, than the air in the posterior chamber, which receives no direct heat, but is always losing heat from its sides and back; and thus, as long as the fire is burning, there must be circulation. The whole mass of air is, in fact, seen to revolve, as marked by the arrows, with great rapidity; so that a person looking towards the bottom of the stove through the stove-door, *i*, might suppose, if smoking fuel had been used to make the motion visible, that he was looking in at the top of a great chimney. The quantity of new air rising from within the fuel, and the like quantity escaping through the flue, *c*, are very small compared with the revolving mass."

To regulate the temperature of this stove and make it equable, a contrivance is attached, called the "thermometer tube," by which the opening for admission of air to the ash-pit is made to expand when the fire burns too slowly, and thereby increase the draught and combustion; and to close a little, and hence to check the combustion, when the fire is too brisk. It would appear, however, that this apparatus was more ingenious than useful, as it is now generally laid aside, and the quantity of air admitted to the fire is regulated by some of various simple methods in common use. One of the advantages this stove seems to possess is, that the fire keeps in a long time, requiring very little attention, particularly when anthracite or coke is employed as fuel. It is rather difficult to light, and therefore some prefer keeping the fire always in, which is rather a convenience, as thus the apartments never cool, and the expense of fuel is very small. Where a gentle, steady heat is very desirable, it appears to be useful; but it must be observed that the means of ventilation must be provided for in the same way as for other stoves.

359. *A few more iron stoves* lately advertised as the *Chunk stove*, *Vesta stove*, &c., do not appear to possess any good qualities peculiar and deserving of mention.

360. *Mr. Stephen Green's new terra cotta stove* avoids several inconveniences of iron stoves. To equalize the heat as much as possible, two or three concentric cylinders of earthenware are introduced between the fire-pot and the external case, which prevents the danger of the heat cracking the external casing, which is also of some kind of earthenware.

Sect. III.—Warming by flues.

361. The method of warming houses by means of flues under the floors or in the walls, though very effectual in some cases, as in hot-houses, is scarcely applicable to our private dwellings as they are constructed at present. It is true that this was the mode adopted by the Romans in their villas when they had possession of this island; but it is to be observed that their floors were altogether of bricks and tiles, often ornamented with mosaics. In the present construction of our houses with floors of wood, it would be next to impossible to warm them in this manner, which would demand so great change in our domestic economy and modes of construction, that we cannot at present speculate upon it; and numerous expensive experiments must be made before we could discover all its advantages and disadvantages, notwithstanding the idea of warming a whole house with one fire, instead of each separate apartment, may appear, at first, to promise a vast improvement. There is, however, one part of the house that might sometimes, perhaps, be advantageously warmed by means of flues under the floor: that part is the hall or vestibule, which may have a pavement of marble, stone, or tiles. Whether this would be sufficient to warm also the staircase, without making the floor of the hall hotter than would be agreeable, remains, we believe, to be decided by experiment.

There are certain other cases where this mode of warming appears to have advantages, namely, in offices, or other places with stone floors, which are very cold for the feet. When this method is employed, the fireplace should be so constructed that the smoke from the fuel must descend through the fire, and be thus almost wholly consumed, which will prevent the great accumulation of soot in the flues.

Sect. IV.—Warming by steam.

362. *Steam*, so useful on many other occasions, is capable of affording *one of the most agreeable, safe, and convenient methods of warming our apartments.* In our account of the general properties of heat, we mentioned the way in which steam is generated, and that its temperature is necessarily always the same, namely, 212°. Hence it presents us with a mode of obtaining always an equable quantity of heat. If an enclosed vessel filled with steam be brought into an apartment, the steam will be gradually condensed by parting with its heat to the vessel containing it, while the latter will communicate it to the air in contact with the vessel. The steam vessel will therefore act as a close stove; with this difference, that the steam stove can never be heated above 212°; and that

the heat given out, being always in proportion to the surface of the vessel, we can, by adapting its size to the occasion, regulate the temperature of an apartment, an advantage which we cannot obtain so completely in any other way.

363. *The manner in which a house or an apartment is warmed* by means of steam is very simple. A boiler supplied with water must be kept constantly boiling by a fire or small furnace; the cover of this boiler must be fixed on tight, and a pipe will conduct the steam to any part required to be warmed, where it may be received in a reservoir, or other convenient receptacle, best suited to the nature of the apartment. As the steam gives out its heat, it becomes condensed into water, which settles at the bottom of the receptacle, and should be conducted away by a small pipe that generally conveys it back again into the boiler. The steam is thus made to carry the heat from the boiler of hot water, depositing or leaving it where it is wanted; and thus this process will be kept up as long as the boiler is at work. Nothing can be more quiet and regular, therefore, than this method of warming; but several precautions are necessary to be attended to. As steam has an immense elastic power if confined, care must be taken that it does not accumulate in too great a quantity under the head of the boiler, otherwise it may become too powerful for the strength of that vessel to resist, and an explosion might be the result—an accident that is well known to have happened frequently. To prevent this, a safety valve on the boiler is requisite. The safety valve is kept down by the pressure of a small weight suspended on a little lever, and, when the steam becomes so powerful as to endanger the boiler, it forces up this valve with its weight, and escapes by little at a time. An ingenious apparatus is likewise employed, by which the boiler is fed with water so as to have always the same quantity in it; as there would be danger in its being too full, and still more in its being quite empty. The pipe, also, which conveys the steam to the part where its heat is to be given out, must be surrounded and protected with some nonconducting material. The steam reservoirs, on the contrary, must be made of the best conductors, such as copper, iron, or tin plate. We stated, when speaking of heat, that a pipe or other vessel cannot be filled with steam until it be first emptied of common air. Contrivances must, therefore, be made in all steam pipes for this purpose; for, should any accident suddenly condense the steam in the pipe, the latter, having been already deprived of its air, would form a vacuum; and therefore, except very strong, could not resist the pressure of the atmosphere, and would be crushed quite flat. There must, therefore, be a valve somewhere to let in the air should this happen. Farther precautions must be taken to prevent the pipes giving way from their frequent expansion by heating and cooling. Considerable difficulty will likewise occur in providing for a situation for the steam reservoirs in our best apartments; although, in many other places, this will be sufficiently easy.

When we take into consideration all these circumstances (and none of them can be omitted), it is obvious that a steam apparatus should be under the direction of a person competent and willing to attend to it, for though in such hands it is perfectly safe and easily managed, it is far too complicated to be employed in ordinary dwellings, where the frequent change of servants would prevent it being properly understood and attended to: the apparatus must be kept in perfect order, and though only a small degree of attention is necessary for this purpose, it does not admit of neglect. The use of steam should, therefore, be limited to those places where it would be put under the management of competent persons. We do not consider it useful, therefore, here to go into the numerous details that would be necessary for constructing and managing a steam apparatus, since every such construction must vary with the locality; and, to succeed, the whole must be executed under the direction of a scientific engineer experienced in such matters. Nevertheless, warming buildings by steam succeeds perfectly in factories and other large places, where there are persons resident, and sufficiently intelligent to be trusted with apparatus requiring such strict and constant attention: and there are cases in domestic economy where it may be applied, but that can only be where persons are conversant with the subject of steam.

Methods of warming by steam, applicable only to hot-houses, do not belong to this place.

364. *Steam has an important advantage* which distinguishes it from every other mode of distributing heat, which is, that it can be conveyed to a very great distance from the boiler, and in any direction; we can cause it to ascend, descend, or move horizontally, with equal facility: but the loss of heat by condensation is considerable in conveying it to a distant point, though steam itself preserves always the same temperature. A single fire to produce the steam may be sufficient for a large establishment, and this fire may be placed where the smoke of the chimney may be least offensive, and its appearance least objectionable; it may even be outside the house to be warmed, and be placed in an adjoining building: hence the superior security from fire. The heat of steam pipes, also, as they never can exceed 212°, is not likely to injure the air.

365. *When steam is employed to warm an apartment in a dwelling-house*, it cannot be admitted in common steam pipes, on account of their form and appearance; but various means must be had recourse to for rendering the steam vessels ornamental: one of the

best is, by collecting the pipes in masses, and covering them with open screen work, in the manner of a side table or pedestals, &c., as at *fig.* 71; or the pipes may be concealed in the walls, or under the floor, and the air admitted by registers; or the steam may enter into a hollow space between two cylinders or cubes, serving as pedestals for statues or vases, by which a great surface of steam might be exposed. In this way steam may be advantageously employed to assist in warming a large apartment, in addition to an open fire, which is seldom sufficient to render every part of such a room comfortable.

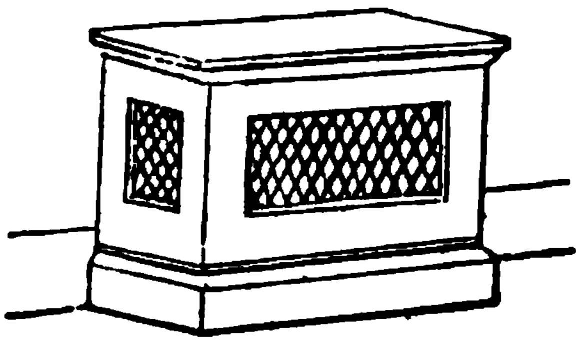


Fig. 71.

SECT. V.—WARMING BUILDINGS BY HOT WATER.

366. *Warming by means of hot water, though one of the last modes brought into practice is of older date than is generally supposed.* It appears to have been first employed by Bonnemain, of Paris, just before the first French revolution. He had in this manner heated the hot-houses at the "Jardin des Plantes" at Paris, and he likewise applied it to preserving an equal temperature in little chambers, in which he succeeded in hatching chickens in the Egyptian manner, without the hen. Afterward, the Marquis Chabannes practised the same mode in England, and succeeded in some hot-houses, but failed in applying it to private dwellings. This practice has lately been revived, and larger pipes of cast iron being employed, hot water is very successfully used in heating hot-houses, or other large buildings where these pipes are not inconvenient.

367. *To cause hot water to circulate through pipes in a building* merely by the action of heat, all that is necessary is to provide a boiler, A, *fig.* 72, filled with water, and closed at the top; a pipe must proceed from the top of the boiler at *a*, entering through the part of the building which is to be warmed, *b*, *c*, and returning back into the boiler at the bottom *d*. This boiler and its pipe, being closed all round, is to be considered as one vessel, and the cause of the circulation of the water will be easily understood if the reader will refer to the description we gave of the currents upward and downward which Count Rumford observed in water while heating. Portions of water heated at the bottom of the boiler will rise to the top, ascend through the pipe, and return again to the bottom; the cooling of the water in the pipe promoting the return. If the whole of the boiler and pipe were to be kept at a boiling heat, this motion would cease; but, as the water in the pipe is constantly cooling, the circulation goes on, and the water, hot, but not boiling, is thus carried to a considerable distance.

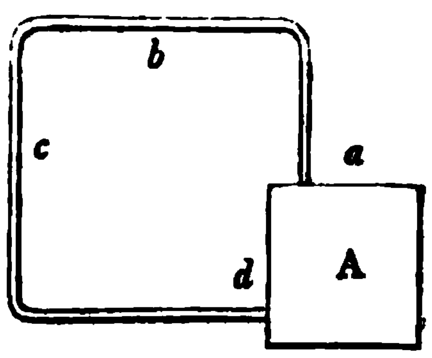


Fig. 72.

There are, however, considerable difficulties in applying this method to warming domestic dwellings. It is necessary to have the pipes of considerable size, several inches in diameter, if circular, that they may contain hot water enough to be effective, and such pipes, which must be of cast iron, are very inconvenient in a private house: also, if they are to ascend to the upper stories, the pressure of the water in them would be enormous, and would require them to be of great strength. From this, and other circumstances, it was found that this mode of warming with cylindrical pipes must be limited to certain places, as hot-houses, conservatories, and public rooms of any kind, where the pipes may be disposed of out of the way, and where there is no occasion to raise the water much above the boiler. In these cases this method by hot water is found to give a very equal degree of heat, and to have some of the advantages of steam, at the same time that the apparatus is more simple, and more easily managed: but we must observe, that it is much inferior to steam in the facility of being conducted to any part of a building, or to any distance, and, therefore, upon the whole, it is much more limited in its application: nor is the regularity of the heat so great as that of steam. The pipes with hot water are, however, sometimes made flat, the section being a rectangle instead of a circle, and thus they are more easily introduced into apartments, being made to appear as part of the skirting, or partly concealed by some artifice. When managed in this way, they have been found to give out a very agreeable heat, particularly when they are employed only as an addition or assistance to an open fire.

To cause hot water to circulate, it is not necessary that the top of the boiler should be closed; but in that case the circulation is effected upon a different principle: the pipe, when once filled with water, then acts as a siphon; the ascending part from the top of the boiler, and just dipping into the water, being the shorter leg, and the descending part, which returns to the bottom, being the longer leg of the siphon. Here the rapidity of the motion will depend upon the difference in the two legs of the siphon, and the different temperatures in the two currents, on the common principles of hydrostatics. This last method has some advantages, with the absence of danger from explosions, the close boiler requiring a safety valve.

368. *The method first employed by Bonnemain is interesting in an historical point of view;*

Fig. 73.

and on this account, and as his mode of hatching chickens by its means has been attempted in London, we shall describe it. *a*, *fig.* 73, is a small boiler, from the top of which rises a tube, *b*, that passes into the inside of a wooden box, *c*, in which are shelves on which the eggs to be hatched are laid. This tube, after being bent backward and forward through the box between the shelves, returns at *d*, and enters into the boiler, passing down to the bottom. The heated water rises through this tube, and circulates through it in the manner we have already described in *fig.* 72, causing the temperature of the air in every part of the box to be very equal. This equality was much assisted by an apparatus which regulates the admission of air to the fire, the aperture decreasing as the fire burned more briskly, and increasing as the fire slackened, as in Arnott's stoves. The details of this contrivance may be seen in Gill's "Technical Repository," February, 1826. *e* is another box, in which the young chickens were fed after they were hatched; in this they nestled under sheepskins with the wool on. In the bottom of the case are little saucers with water to supply the humidity to the air which is necessary to hatching. *f* is a safety valve to the boiler. We may mention it as a remarkable fact, that although the hot-houses in the botanic gardens of Paris were thus heated fifty years ago, yet this had been so completely forgotten by the French gardeners and engineers, that their government sent to England, in 1822, a deputation of professional men to study the subject, with the view of again heating their hot-houses in this manner.

309. *The employment of hot water for warming houses has, however, been extended by Mr. Perkins*, in consequence of a method which he adopted of conveying water in pipes heated far above the boiling point, even as high as from 300° to 600°. It will strike the reader that, as water can only be heated to 212° in an open vessel without being converted into steam, there must be here some particular contrivance by which the heat of water can be raised to 300°. The fact is, that provided the steam is prevented from escaping, or even forming, by the vessel containing the water being completely closed, that fluid may be heated to any degree that the vessel will bear without bursting; but in this case, the pipes conveying water heated so much must be sufficiently strong to prevent such an accident.

The method of Mr. Perkins, called by some the *high-pressure hot-water apparatus*, consists of a considerable length of an iron pipe, which, in consequence of being so intensely heated, is made only an inch in diameter; this is filled with water, and completely closed in all its parts. A portion of it is made in the form of a coil, *a*, *fig.* 74, either round or square, which is placed in a furnace or fire, and the water in it heated to 300° or more. The rest of the pipe is carried round the rooms to be warmed; and, if necessary, it is coiled also somewhere in the apartment, *b*, in order to get more pipe into little space; for the longer the pipe, the more heat it will give out. This pipe afterward, and of course the water, returns back to the coil in the furnace. As in the other mode of heating by hot water, one end of the pipe proceeds from the top of the boiler, while the other returns to the bottom of it, so in this the pipe goes first from the top of the coil and returns to the bottom of the coil, *c*, for there is no boiler. In order to allow room for the expansion of the water on being heated, which might otherwise occasion the bursting of the pipes, a tube, *d*, is fixed at top, which holds about one twelfth as much water as the whole pipe; into this the water finds its way on expanding. This hot-water apparatus, on account of the smallness of the pipes, and their flexibility, can be introduced into apartments without much difficulty: it may be led round the room near the floor, or made into a coil in the chimney, the flue being first stopped, or in any other convenient situation; and the heat may be raised to any extent that the pipes will bear.

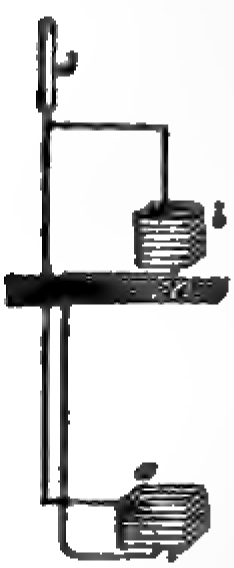


Fig. 74.

But although this ingenious invention can be used in places where the former method with larger pipes could not be introduced, nor steam-pipes either, without much trouble, yet it is liable to some defects, which must be noticed. One, that is very obvious, is the danger of accidents, by the bursting of pipes containing water so intensely heated; although the pipes may be manufactured upon an excellent principle, and proved before they are used, yet we cannot, without a caution, recommend a plan in which safety depends so much upon the care or the skill of workmen. It is also said that, in consequence of the intense heat of these pipes, rooms heated by them have, to a certain de-

gree, the same disagreeable and unwholesome smell which results from the use of cockles or iron stoves in general, when much heated. Another objection, stated by Mr. Hood, appears to be the inequality of temperature in buildings heated by these pipes, in consequence of their being much hotter in one part than in another, a difference sometimes amounting to more than 100°, varying according to the length of the pipe, which may extend above 1000 feet. From the smallness of the pipe, also, this apparatus cools so rapidly when the fire slackens, that the heat of the building will be materially affected even by a very little alteration in the strength of the fire. From all these circumstances, this mode of heating will not afford the same steadiness of temperature as hot water with large pipes, and still less than that obtained by the use of steam. Notwithstanding, however, these serious objections to applying Mr. Perkin's method generally to ordinary dwellings, it has been employed in several public buildings, and, we understand, with considerable success. There are certain situations, indeed, where it would be extremely difficult to employ any other method. It has, for instance, been found very serviceable in the Register Office, Edinburgh, where records of great value are kept; where, of course, safety from fire is eminently important; and where no method of warming the building had been contrived on its erection. The museum in Lincoln's Inn Fields, left to the public by the late Mr. Soane, is mentioned as another instance.

Both the steam and hot-water system of the ordinary kind, with large pipes, are safe as to risk from fire; but it has been stated lately that Perkin's method is not free from danger, since pipes heated to so great a degree are capable of setting fire to many substances: care should, therefore, be taken that the pipes do not come into contact with any materials that are inflammable.

It is evident that the same difficulties of ventilation must attend this as all other stoves: and this consideration, were there no other, must also determine in what place it can be introduced with propriety in a domestic edifice. The idea is undoubtedly ingenious; but it cannot for a moment be supposed that it ought to supersede open fires for our ordinary apartments, as some have been sanguine enough to imagine.

Sect. VI.—Warming by hot air.

370. Warming by hot air is first heating a quantity of air to a considerable degree, and then bringing it into the apartments through pipes or other apertures. This has been effected in various ways.

371. *The first method employed* was a French invention, and accomplished by causing air to circulate and get heated *behind the iron back of the fire*, and then introducing it through a register.

372. *Another method consists* in making an iron tube *pass through the fire*, the mouth being in the open air: the air entering the tube is heated by the fire, and discharges hot air into the room. Likewise, chambers are filled with air heated by iron or brick stoves; and from these reservoirs the various apartments are supplied by means of pipes.

In all these methods of warming apartments, the air has generally been heated too much for salubrity; and in most of them it has been rendered very unwholesome; added to which, the apparatus is always complicated and expensive. It is to be observed that the first two of the above methods act only partially, being intended only to assist an open fire, and they may be named *stove grates*. A great number of these, of various constructions, have been put up in England of late; but they are very ineffective, and extremely unwholesome, from the air issuing through the register being vitiated by the heated iron. When heated air is introduced from them by way of assisting an open fire, it is of little use, for the following reason: as soon as it enters the room by the register on the mantel-shelf, it rises to the ceiling, instead of readily diffusing itself through the rest of the air in the apartment; and is, in reality, worse than nothing, adding scarcely anything to the temperature, but contributing a quantity of disagreeable effluvia: these contrivances are, accordingly, now nearly laid aside.

373. *Of the very unwholesome nature of air made hot by iron*, we have an instructive account in a late examination, by Dr. Ure, into the cause of the indisposition and disease which prevailed among the officers in the long-room of the Custom-house. The hot air was discharged from two stone tunnels at from 90° to 110°, but diluted afterward with cold till about 60° or 62°; yet the effects experienced were very distressing, and the air was found seriously to affect the constitutions of numerous individuals of various ages and temperaments. In one room, where the air that issued was 170°, it is described as resembling in its properties the simoon of the desert, possessing, in an eminent degree, the dryness and disagreeable smell imported to air by the action of red-hot iron. "As cast iron," Dr. Ure observes, "contains, besides the metal itself, more or less carbon, sulphur, phosphorus, and even arsenic, it is possible that the smell of the air passed over it in an incandescent state, may be owing to some of these imperfections; for a quantity of noxious effluviæ, inappreciably small, is capable of affecting not only the olfactory nerves, but the pulmonary organs."

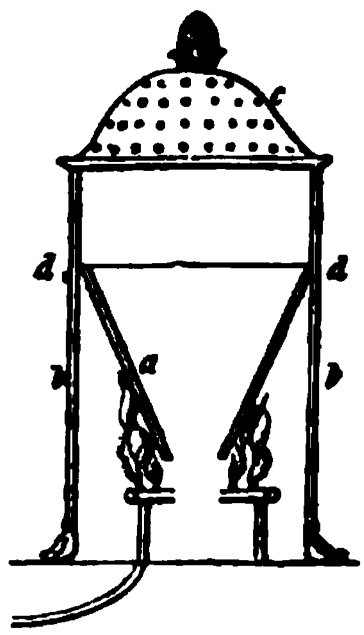
There is another objection to the warming apartments with hot air, in the mode in which it has been usually practised; which is, that the supply of hot air is frequently ir-

regular, coming often in currents or puffs; and a current of hot air is equally injurious to health as a current of cold air. Heating by steam or hot water is far more even and regular.

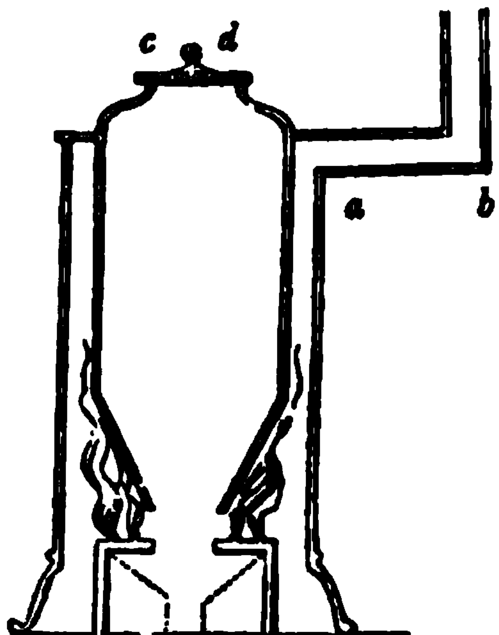
374. *Nor, independently of the usual unhealthiness of air much heated, is the danger from fire to be overlooked in this system.* In a complication of flues and pipes passing through the various parts of a private dwelling, some of the flues for the smoke will perhaps pass near to woodwork, and the smallest crack or defect in the workmanship, which scarcely any care in the superintendents can guard against, may occasion intense heat, and even flame, to be carried to parts where it may be dangerous. We may instance the lamentable destruction of the Houses of Parliament among others, which have been occasioned by the hot-air system; to which we add, that it is now believed that many conflagrations have been occasioned by similar causes.

375. *But there is another way in which heated, or, rather, warmed air may be employed, and that advantageously.* If it be warmed in a separate chamber, by means of steam or hot water pipes, and then introduced into apartments, such air, if originally pure, will continue to be perfectly salubrious; this method of moderately warming it not injuring its quality, as has been already explained when treating of the modes of warming by steam and hot water. The chief difficulty here is to find means of introducing it; for it must be evident that it is impossible to throw in such warmed air except an equal quantity of cold air can be abstracted: this operation must, therefore, be connected with artificial ventilation, and will probably be found too complicated and expensive for ordinary domestic purposes, though very suitable for large public buildings, as may be instanced in the new Houses of Parliament, which are warmed upon this principle.

Sect. VII.—Warming by Gas.



376. *Coal gas is also occasionally employed to warm the interior of buildings.* A flame has no effect in warming the air surrounding it, as was explained under "Heat;" where it was stated that radiant heat could not warm the air it passed through. But when flame strikes on a solid substance, the latter is heated, and then communicates its heat to the air in contact with it, which, ascending, gives place to another portion to be warmed in the same manner. The gas stove is made upon this principle. A circle of gas flame near the floor is made to play upon the outside of a hollow inverted metal cone, *a*, *fig.* 75, which is open at bottom, and surrounded by the cylinder, *b b*, standing upon three feet, but open all round the bottom. The air within the cone is heated by the metal, and rises up, permitting a fresh portion to succeed it, which enters from the open bottom; and the heated air comes out into the room by the apertures, *c*. The whole has the form of a circular pedestal. When this stove is constructed in such a manner that the deleterious gases, arising from the combustion above mentioned, are suffered to escape into the apartment, as is sometimes the case, through apertures *d d*, where the cone joins the cylinder, it is highly objectionable in confined situations. Perhaps, in some cases, as a lofty chapel, where the service is not long, the unwholesomeness of it may not be much felt. But it is proper that the true nature of the stove should be understood. No combustion can take place without a certain portion of the air being injured in consequence. Mr. Ricketts, of Agar-street, Strand, aware of this, makes his gas stove as in *fig.* 76, where the poisonous gases generated are carried out of the apartment by a tube, *a b*, and only pure warm air issues from the stove by the register, *c d*. In this form, this apparatus may be used for warming, and has some advantages. It occupies very little room, and may be put up wherever gas can be conveyed, and the deleterious gases carried away. The heat of the stove may be very accurately and very simply regulated, only by turning the cock of the supply-pipe, by which the flame of the gas may be increased or diminished. It is to be observed, however, that if the iron be very much heated, the effect upon the air coming from the stove must be of the same pernicious kind as that which is usually felt from highly heated iron. When the apparatus is made of cast iron, it is not apt to be so hot as when made of sheet iron, and is not only much more durable, but is less apt to injure the air.



Sect. VIII.—General and Concluding Observations on Warming Domestic Buildings.

377. We have purposely avoided giving any opinion as to which method may be considered as the best, until we had placed before our readers the various modes of warm-

ing our dwellings. The variety of opinions that are afloat on this subject occasion, with some persons, considerable perplexity; but much of this difficulty will probably disappear by consulting principles rather than authorities. Each method has some advantage, and likewise some disadvantage, to counterbalance it; and the subject has seldom been treated by persons wholly disinterested: these have too often held up to view merits or demerits, as best suited their objects.

378. *It has been a fashion for some years past, with some persons, to exclaim against our chimney fireplaces,* which have been long adopted in this country, and which still continue prevalent. Thus, we are told of the immense waste of fuel which they occasion; of their dirt and smoke; of their scorching us on one side, and chilling us by a cold current of air on the other side; and that, therefore, it is no wonder we are attacked by colds and rheumatism. It is said, that no sooner is any portion of the air warmed by an open fire, but it is hurried up the flue; that the temperature of the air is very unequal in different parts of the room; that there is a stratum of warm air above the mantel, but that our legs and feet are immersed in cold air. They are, indeed, represented as if the pecuniary interests of the coal merchant and the physician were studied at the expense of the pocket and of health. In short, all their defects are collected and exaggerated, without their advantages being pointed out; while other methods are lauded, and placed in the most favourable light. And this is not even the worst; for the oldfashioned, long-abolished chimney has been selected for pointing out defects, instead of the best constructed Rumford chimneys and grates, with all their late improvements. There can be no doubt that chimney fireplaces have defects; but so have all the methods of producing artificial warmth that were ever invented; and it is only by balancing in the various cases advantages and disadvantages, that our choice should be determined.

379. *It might be supposed that, since Count Rumford did so much towards the improvement of chimney fireplaces, he was an enthusiast in favour of the mode of warming our houses through their means; but that is not the fact.* He found our fireplaces in a wretched condition, and our houses badly warmed and ventilated; and despairing of overcoming what he considered as our national predilection for open fires, he set himself about rendering them as little hurtful to health, and producing as much comfort, as possible. In this endeavour, he succeeded in a high degree; but he would have preferred warming our apartments by stoves of some kind, in favour of which he expresses himself very stongly in his twelfth essay. He maintained the opinion that *warm* rooms are very beneficial to health; and observed, that he had gone to Germany with as strong a prejudice against them as anybody, but that, after having spent twelve winters in that country, he had learned to know the advantages of rooms warmed by stoves.

The writer of this article assisted him in erecting several stoves in his house at Brompton; but it must be observed that they were all of brick or earthenware, and that he considered iron stoves as pernicious. He remarks in one of his essays, that "it is a question often discussed in this country, whether living in a warm room in winter be, or be not, detrimental to health:" and it is to be regretted that no one, since his time, has applied to this subject that proportion of science and experience which its importance demands. This is not the place to enter upon such a discussion, which would be much more difficult than most persons are aware of, as may be gathered from the conflicting opinions of various persons. For instance, Count Rumford states "that the Swedes and Russians live in very warm houses during their long and severe frosts, yet no people are more strong and healthy than they are, nor are there any less liable to catarrhs and consumptions." On the contrary, Mr. Tredgold quotes a statement by the benevolent Howard in these words: "In a conversation with the physician of the military hospital at Moscow, on my observing that the windows of the wards were shut, he answered, almost all our disorders are in the winter, for the Russians enclose themselves in hot rooms, and dislike the fresh air, even before the cold months commence." We may observe, that it is impossible to determine upon the propriety of the practice of one country by that of another, so much depending upon climate, habit, and various local circumstances. The climate of Russia is very different from ours. They have a constancy and duration in their cold weather, which we have not; and this enables them to dress accordingly. The changeable nature of our climate forbids our imitating them in many respects.

380. *This great variableness in the nature of our climate furnishes, perhaps, one of the best arguments in favour of our chimney fireplaces,* by which we can more readily alter the temperature of our apartments than by any other method. It is one of the chief characters of stoves, that they give a very regular heat; but as it is difficult to charge this in a short time if required, they may not be found so suitable to our climate. In this country we often experience the warmth of several different climates in the course of a single day. Should we come into a room with an open fire, and find the apartment too hot, in a very few minutes we can, by taking off some fire, make the room cooler; to say nothing of opening a door and window: if the room should not be warm enough, the fire may be stirred up, or more coals added; a good fire may soon be made. We could

not effect these changes so easily with any kind of stove. Should we with them let out the air of the room that has been warming very slowly, we cannot get it up again to its former temperature but in a considerable time. We feel some benefit from a fire the moment it is kindled: not so with the stove; it must be lighted long before it gives sufficient warmth to the room.

381. *But there is another circumstance seldom thought of; an open fire does not, as we have stated, warm the air of the room directly, by passing through it;* the air is only warmed slowly by means of the walls of the room: therefore, while we feel, beneficially and agreeably, the radiant heat of the fire, we are breathing all the while a cool atmosphere. In a stove, on the contrary, this can never be the case: it is the nature of a stove to warm the air itself before we can feel the benefit of it, and we then breathe air considerably heated, often equal to that of a hot climate. This is apt to relax the body, and, without good management, may often prove injurious. Should this air be dry as well as hot, it is ten to one but we get a cold should we enter from a damp air, owing to the rapid absorption of moisture from our clothes, an effect which will not happen in the cool air of a room warmed by radiant heat. Should this warm air have been produced by an iron apparatus, we have already shown how unpleasant and unwholesome it generally is. But the advantages of our chimneys appear most striking in the case of ventilation, which with them goes on of itself, without any thought about it. While a fire is burning, a change of the air *must* happen; but with a stove, ventilation stands nearly still, and it is extremely difficult to effect, as it must be accomplished by other means: at least, it is more difficult than is usually consistent with the knowledge that may be expected from ordinary servants, and which will prevent its being performed well without much better superintendence. We shall say nothing here of the agreeable appearance of a fire, since this may be habit and prejudice, and other objects may be found equally agreeable; nor of its accessibility, since this is, perhaps, counterbalanced by its danger.

382. *Much has been said, as we have just observed, respecting the unequal manner in which a room is warmed by a fire, and of the perfect equality of the temperature in every part of a room where a stove is used.* This is, perhaps, the strongest point in favour of stoves, and, to invalids, is no doubt of the highest importance. Where the air is not injured by a stove, and the temperature preserved with great uniformity, there can be little doubt but these advantages are considerable where the lungs and state of health demand great care. But for persons in good health, this perfect equality of temperature does not appear so desirable. It does not exist in nature. The sun warms as unequally, and the warmth of his rays, with the cool freshness of the air, are agreeable, and not unwholesome, sensations. The inequality of heat in various parts of a room, though we could wish rather to correct it, has its advantages, and it would be difficult to find any degree of heat that would suit every one's feelings: some would feel it too warm, others not warm enough; but, with a fire, we can choose our places; we can draw nearer to the fire, or remove farther off. There is a certain distance from a fire that is most agreeable and most proper; not far enough off to lose the full benefit of the radiant heat, and not near enough to be in the decided current that feeds the fire. To sit quite opposite to a fire is particularly unpleasant, and often dangerous; as this is the strongest part of the current, many a cold is got by sitting directly opposite to a fire. The old-fashioned folding screens were found extremely useful, when, our fireplaces not being so good as at present, the draughts were more felt; and they are still occasionally employed with advantage.

383. *Various other reasons might be assigned for our adherence to the custom of warming our apartments by fires in open grates,* besides national prejudice in their favour. The frequent change of the occupiers in our cities, and the variety of wants, opinions, and tastes, form considerable objections to the introduction of any fixed and immovable modes of warming, while the abundance of our iron and coal, and the facility with which the former is wrought into grates extremely cheap, yet elegant in their appearance, and the ease with which they may be moved from house to house, and changed according to the taste of the occupant, together with the industry of our ironmongers, who hold out such temptations in every show-room, furnish so many reasons, among others that might be enumerated, for the continuance of their use. Besides, although they certainly are not the most economical apparatus, they are the simplest, and most easily managed, and, therefore, best adapted to the general habits of servants. Few people take the trouble to consider the difference between a badly constructed grate, and one made and fitted up upon the best principles, which are really little understood; and those who are disposed to quarrel with our fireplaces, do not care to select the best kind when they are disposed to criticise.

With our present existing edifices, our habits, and our fuel, there is little doubt but that we must continue for a long time the use of open fires; and that it will be most prudent to follow the example of Count Rumford in improving them as much as possible, until something better be fairly established or clearly demonstrated. If they have defects, they have likewise many advantages over other modes; and it may proba-

bly be ultimately found that the fondness for an English fireside is not merely a prejudice.

384. *Perhaps the greatest improvement that can easily be effected at present in rendering our houses comfortable, is to warm the air of the hall and staircase;* as all the upper apartments communicate directly with the latter, or with passages connected with it, whenever any door is opened, a rush of cold air enters; and every draught through crevices in the rooms feels unpleasant from the same cause; whereas, if the air of the staircase had a proper temperature, it would not only feel agreeable in passing from one part of the house to another, but all cold draughts would be avoided, with the exception of such as the windows occasioned; and this might be prevented by having double sashes in winter. But, if the staircase is to be warmed, the choice of the mode must be considered; since, if the air in it be in any way deteriorated, it must injure that of the whole house. Warming by heated iron we have said enough against: steam or hot water, and even brick stoves, are unobjectionable, except on the score of trouble and expense; but by no means should the air supplied be taken from the basement story, or from offices of any kind, but from some place out of doors, where the air is pure. Perhaps the best thing, where there is space, will be found to be a brick or earthenware stove, somewhat after the Russian or German fashion: these are easily managed, are not expensive, and do not injure the air.

Except the staircases are warmed, it will scarcely be possible to render very large apartments sufficiently comfortable by open fires alone, although this is extremely desirable on account of ventilation; but it would be easy to assist them by the introduction of steam heat, either by having steam pipes or vessels in the room, or by the admission of air previously warmed by steam pipes. The first of these methods is not only the simplest, but likewise the best, where it is practicable.

It is proper to observe, that although skylights in winter cause a great loss of heat, yet in summer, when there is strong sunshine, the air is heated by them to an intolerable degree. On these occasions, during the hot periods of the day, it would be extremely useful, in order to keep the house cool, to cover over the skylight with some cloth kept for the purpose, leaving just enough to afford the necessary light, a practice very common in warm climates. Through neglect of this, many houses are rendered very uncomfortable in hot weather. During the hot hours of the day, all windows should be kept closed, to prevent the admission of hot air. There cannot be a greater error than keeping the windows open in the heat of the day in very hot weather, for the air is then hotter out of doors than within.

385. *With regard to the degree of temperature proper for apartments*, it is not possible to lay down any invariable rule, since so much must depend upon particular constitutions and feelings, as well as other circumstances. General principles only can be stated. A thermometer is necessary to regulate the temperature where accuracy is required. In man, the natural animal heat, in a state of health, is about 98° of Fahrenheit, whether in the tropical or polar regions; and we have stated that this natural temperature is maintained by the function of respiration, checked by the cooling effect of perspiration. Clothing prevents the undue escape of this animal heat; but, as that protection is not perfect, it is necessary to regulate the temperature of the surrounding air within doors. It is stated by medical writers to "be a good rule for persons in England to clothe themselves in winter so as to be comfortable in a room at a temperature of 60° or 62°, and to let that be the steady temperature of their common apartments, which it could then never be dangerous either to enter or to leave." Rooms in England, where the thermometer is seldom kept, are often heated up to 70°, or so low as 50°. Accustoming ourselves to too great warmth in doors relaxes the system, and renders it more sensible of the cold out of doors, as also of those changes to which our climate is liable. We become somewhat in the condition of hot-house plants, instead of such as grow in the open garden. But though a certain approach to an equality of temperature be very desirable, we are not friends to persons in health having too great solicitude respecting it: there being no possibility of avoiding variations of heat and cold, it is better to accustom ourselves somewhat to changes of temperature. With respect to invalids, the case is different. When a staircase is warmed, the air to be admitted into the rooms may be kept at 56°, and not above that. A somewhat warmer temperature is proper for a sitting-room than for a bedroom.

SECT. IX.—ON SMOKE.

386. We have described smoke as an extremely fine dust, composed of unconsumed fuel that is carried up by the heated air; and, as the air is invisible, it is usually, by unscientific persons, confounded with the smoke itself. The cause of the ascent of the heated air carrying the smoke with it is its lightness, from being rarified by the heat. The more the air is heated, the more it is rarified, and of course the greater will be its power of ascent. Though smoke in the open air ascends at first, it soon diffuses itself on every side, and, when it cools, its particles fall down; in a flue it is confined, and will have a force of ascent in proportion to the height of the flue and size of the fire.

387. *It is not uncommon for short flues to draw badly*, as it is called; that is, to have little power of ascent: the remedy for this is to heighten the flue, if this be practicable.

388. *Flues ought to be constructed with great care*, and by an experienced bricklayer, although few things so important in a building are more carelessly executed; which is the more lamentable, since their defects can seldom be remedied, and are sometimes very difficult even to be ascertained.

389. *The most frequent cause of smoky chimneys is the width of their throats:* when that is the case, contracting the throat will remedy the evil.

390. *There can be no good reason why any chimney in a new building, constructed by an architect who understands the principles of his profession, ought to smoke*, except, indeed, there should happen to be in the vicinity some buildings still higher, from which, when the wind blows in a certain quarter, it may be reflected and beaten down the flue; or where there are high rocks, hills, or other objects that may have a similar effect.

391. *Since the cases must vary with every locality, no specific rules can be given for the guidance of the chimney doctor*, generally a quack, who promises to cure every smoky chimney with his infallible nostrum; and we can only recommend the bricklayer and architect (whose province this should be) to study the scientific principles upon which chimneys should be constructed, without which they must always be in the condition of persons groping in the dark.

When it is supposed that the cause of smoke is the beating down of air from the top from any higher adjoining buildings, or other objects, a common remedy is adding to the top of the chimney-pot a *cowl* or *turncap*, which, by turning round with the wind, gives a shelter to the smoke that issues: of these there are an almost infinite variety of forms, made of sheet iron painted, or of zinc: some of the latter appear to answer very well, particularly Day's patent windguard. Chimney-pots, likewise, of several forms, are made with the same view.

392. *It will sometimes happen that smoke comes down a chimney when there is no fire in the room.* This is generally occasioned by a current of air setting down the flue, and thus drawing the smoke from a neighbouring one. This must be corrected by some contrivance at the top.

393. *When neither contracting the throat nor putting on a turncap will have the desired effect*, the cure of the smoky chimney will probably prove difficult: *one method* we have seen described as "infallible;" this is to have a grate made so that all the front opening of the chimney may be shut up except that part just opposite the fire, thus converting the latter into a furnace, no air going up the flue except what passes through the fire. This is, indeed, generally a "cure for the smoke;" but by it, likewise, nearly all the heat goes up the chimney and is lost, so that there might nearly as well be no fire. Any one may make this addition to a grate, as a last resource when all other methods fail, by a plate of sheet iron, a contrivance well known by the name of a *blower*, which, by-the-by, is a good way of making the fire burn up upon occasion. A method, however, allied to this, but very different, has been practised with success, and found useful. This is, to carry the blower down even *before* the front of the fire, allowing the air feeding the latter to come only through the bottom of the grate, and to have even a register to this by which more or less air may be admitted: thus the fire may be kept in a long time by a very small quantity of air.

394. *Some attempts have been made to destroy the smoke from open chimney fireplaces*; but as none of these have been sufficiently successful to get into use, we do not think it necessary to occupy our pages with any description of them. Indeed, to accomplish this completely will evidently be a very difficult task, as may easily be conceived by those who will study the principles of chimney fireplaces and the generation of smoke. It is necessary likewise to observe, that, supposing smoke could be destroyed, which it might be practicable to do, particularly if close stoves were universally adopted, yet the flues (for these must still exist) would continue to vomit out on the house-tops the same deleterious gases as at present, and only in less quantity in consequence of the diminution of fuel. The smoke itself, though productive of much inconvenience from the soot and dirt it occasions, and which is really a serious evil in large cities, is not the most unwholesome part; that is the poisonous gas, or burned air, as it is vulgarly called, which we have shown to be wholly inseparable from the combustion of fuel, whatever kind that may be of. The smoke from coal fires, as is well known, not only blackens the exterior of the buildings by means of the particles of soot of which it is composed, but finds its way into our apartments, and even into the inmost recesses, staining everything contained in them, whether works of art, objects of natural history, or other precious articles.

It has been calculated that about one eighth part of the coal used as fuel is consumed and lost in the smoke, and that in this manner 100,000 chaldron of coals are annually applied in London to the blacking of our buildings, and the contamination of our atmosphere.

395. *That the smoke of furnaces for steam-engine boilers, hot-house boilers, or similar works, where the fireplaces are of the closed kind, can be effectually destroyed*, has been proved by several inventions for which patents have been taken. An act of Parliament was passed by the Legislature some years ago to compel the proprietors of manufactories in large

cities to burn their smoke; but we cannot here investigate the reason why this regulation was not complied with. The principles upon which it may be done cannot be very difficult to understand, when we consider that smoke is merely the unburned fuel that has escaped because there was not sufficient oxygen present to complete the combustion just at the part where the smoke separates; and this will be farther illustrated by referring to our explanation of the action in an Argand's lamp, where the smoke is completely destroyed.

With respect to manufactories, perhaps the best thing for many of them to do is to employ as fuel, coke, or else anthracite, the stone coal of South Wales, neither of which give any smoke when used alone, and when mixed with a small quantity of Newcastle coal, which is necessary to make them burn well, give very little. The committee of the metropolitan improvement has of late taken up this subject in earnest, and it is to be hoped that they will succeed in bringing about a reform. It is stated that Mr. J. Cubitt has completely destroyed the smoke in his new furnace chimney near Vauxhall Bridge. Williams of Liverpool, as well as others, have done the same thing.

SECT. X.—SWEEPING CHIMNEYS.

396. The collecting of soot in chimney-flues requires that they shall be frequently swept, and since a happy change has been made by the Legislature in the mode of effecting this, much of what we had originally written on this subject is now rendered unnecessary. For a century, at least, it had been the universal practice to sweep chimneys in England by sending little boys up these dark and dreary funnels; and were not some record preserved that this method was resorted to, it would scarcely be believed by posterity that children were ever used for the purpose.

397. *It had long been shown that the end might be answered by machinery*, but the determined opposition of the master chimney-sweepers had prevented the use of the machine from becoming general, and they continued to prejudice the public mind by representing that a large proportion of chimney-flues could not be swept except by the employment of boys. The fallacy of their representations having been at last sufficiently demonstrated, and this disgraceful and inhuman practice being now abolished, doubtless for ever, it is not necessary that we should point out all the evils which were consequent upon it, and we shall only refer to those circumstances which are connected with the present practice of sweeping.

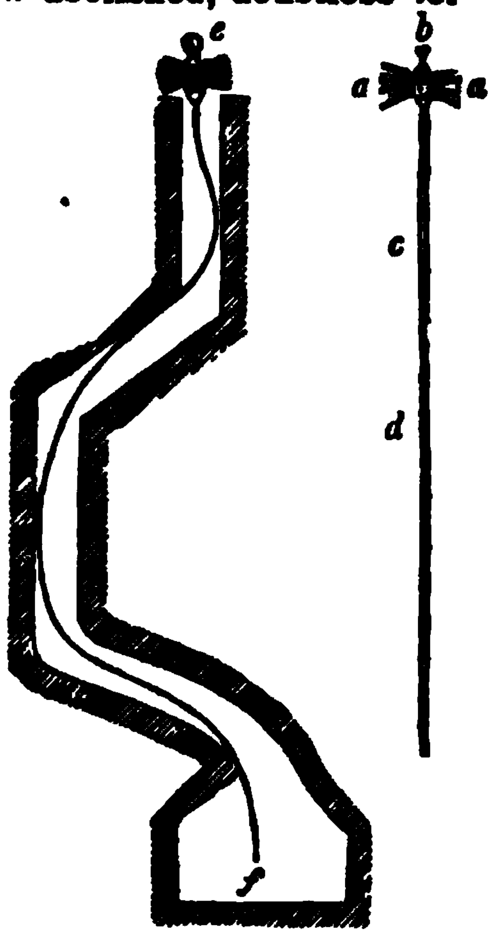
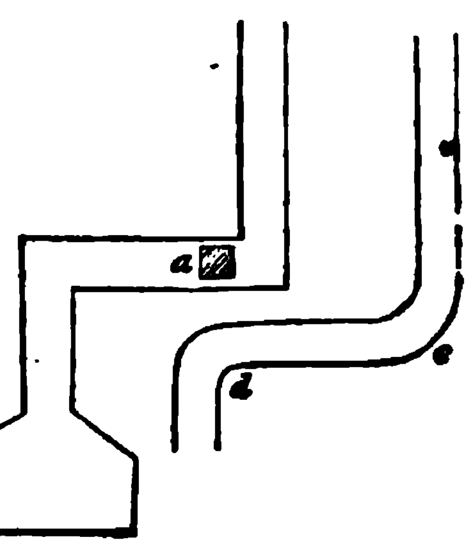


Fig. 77.

398. *When the flues are straight*, or have few or slight bends, without any of these being at right angles, there is no difficulty whatever in sweeping them with a machine, such as that invented by Mr. Smart, and afterward improved by Glass, *b c d*, *fig.* 77. This is composed of a large whalebone brush, of a peculiar construction, and fine cane rods three or four feet in length, attached to the brush. Length after length of the rods are firmly screwed on as the brush is forced up the flue, and unscrewed and laid aside when it is brought down, the flexibility of the cane permitting its easy ascent through the windings of the flue. The brush, *a a*, is made by inserting little bundles of strips of whalebone in small holes in a wooden stock. These strips are eight inches in length, which makes the brush, including the stock, twenty inches in diameter, and, consequently, sufficiently large to fill the flues, which are never made in London more than fourteen inches square, and seldom more than fourteen inches by nine. To make it pass more readily up the chimney, a small wheel, *b*, is fixed to the top of the stock. *e f* represents the machine in the flue passing the various bends. Some attention by the sweeper is necessary to ascertain when the brush has actually arrived at the top: from neglect of this, some have thrust the rods so far out, that they have fallen down upon the roof; others have damaged the chimney-pots, and when these have cowls or other contrivances to prevent smoke in the apartments, the sweeper, by forcing up the machine, has sometimes driven the top off. Practice and experience will prevent these accidents.



399. *The most difficult flues to sweep* are generally those where there is a right angle, as in *fig.* 78, part of the flue being horizontal: these angles it was almost impossible for the boys to pass, and never without great danger, partly from the difficulty of bending their bodies sufficiently, and partly from the accumulation of soot there, owing to its falling down. In these it was necessary to have a soot

door, *a*, made of iron to close tight, through which the horizontal part could be swept. But as this is on other accounts a bad construction, such flues are now always made with the corners rounded off, as at *c d*. Also, when any difficulties occur, on account of such a bending of the flues as cannot be surmounted by machine sweeping, soot doors are required, by the new act of Parliament, to be placed in proper parts to introduce the brush through. These soot doors are, of course, best placed on the outside of the house, if possible, but sometimes it is necessary to put them on the inside, and even in apartments, in which they may be concealed by a picture or frame of some kind.

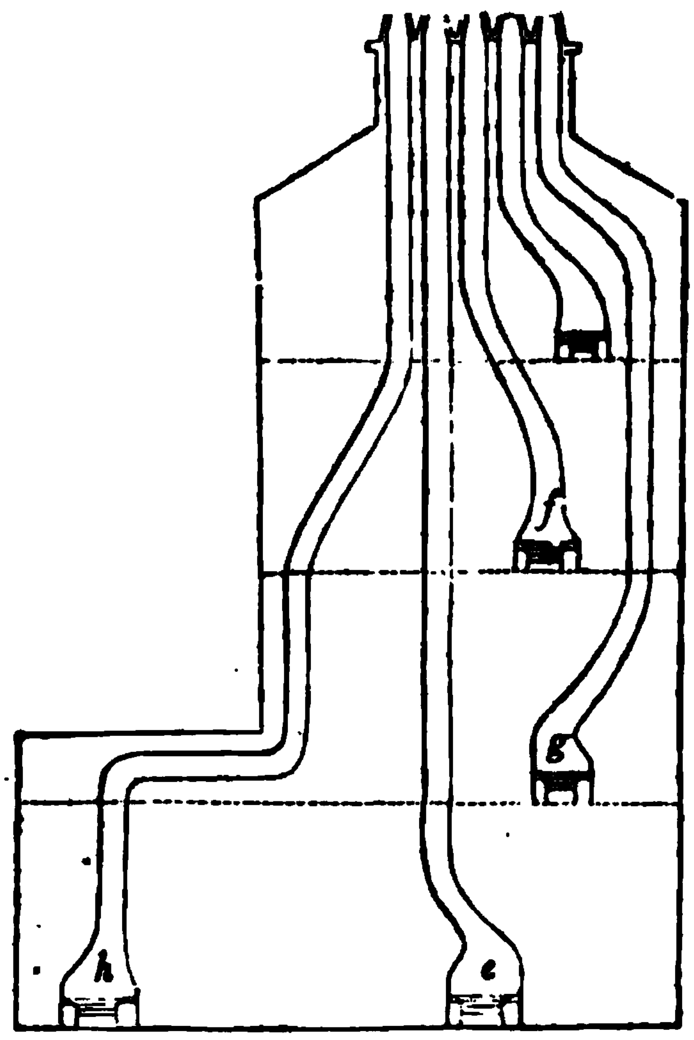


Fig. 79.

400. *Fig*. 79 exhibits the usual manner of bending the flues in the party walls of houses in London, so that sudden turns should be avoided as much as possible: *e f g h* are fireplaces. The fireplace, *h*, is supposed to be that of a kitchen under a lead flue at the back of the house, in which case part of the flue is usually horizontal.

401. *Other methods of cleaning chimneys*. In many parts of Scotland climbing boys are unknown, and the chimneys are cleaned in the following manner: An iron or leaden ball, or a stone, of a few pounds' weight, is fastened to the end of a long rope, and a man, taking this to the top of the chimney, lets the ball drop down the flue, dragging after it the rope. When the ball arrives at the bottom, another man draws the rope a good way down into the apartment, and fastens a bunch of heather to the middle of it; this bunch is then drawn up to the top, and the two men alternately pull up and down a little way at a time, until the whole of the flue has been subjected to this operation, by which means the chimney is perfectly cleaned. In that country the flues are usually rather wide, and there are steps by which the tops of the chimneys are easily reached: instead of such a bunch of heather, a round brush might be substituted in smaller flues.

402. *The present change in the mode of cleaning chimney flues will no doubt give rise to various improvements in their construction*, of which examples may be given in two papers lately read at the Society of Arts. The first is by *Mr. J. Sylvester*, "On the Construction of Flues and Fireplaces," and is thus stated in the Atheneum.

The object of this plan is to obviate the inconveniences arising from the necessity incurred by the ordinary method of building flues, of sweeping or cleaning every flue into the fireplace of the apartments to which it belongs; and also to avoid the nuisance of daily carrying away the ashes through the furnished apartments. To remedy these evils, Mr. Sylvester proposes to build every flue perfectly vertical, each flue for every fireplace, in all the stories, not only to ascend to the chimney top on the outside, but also to be continued downward into the basement, in one line from top to bottom, the fireplaces or grates not being under the flues, but in front of them, on the surface of the wall, surrounded by a chimney-piece, as a decorative piece of furniture. The smoke from the fire is made to pass through an aperture into the flue at the back, which, when the fire is not in use, can be closed by an air-tight sliding door, while another opening into the flue, under the fire grate, admits of the ashes, dust, &c., being cleared away into the descending or tail flue, whence it falls to the bottom of the flue in the basement story. By this means it is merely necessary, when a chimney requires sweeping, to close the door at the top of the grate, and the sweep may go into the basement story, open the door at the bottom of the descending flue, and take away the soot and ashes there collected. He may then, by the use of the machine, brush down from top to bottom any small portions of soot that may hang to the flue, when the whole can be removed, without the slightest interference with the room to which the flue belongs, unperceived by its inmates. The whole of the flues in a stack may be swept at the same time with as little inconvenience as one, since they all descend into one chamber, and open at the same level.

403. *Another improvement has been suggested by Dr. Atkins*. He proposes to place a series of three layers of wire gauze, four inches apart, in the aperture of the chimney, the first layer at the distance of eighteen inches or two feet above the fire, the distance being regulated according to the nature of the fuel used. Each layer consists of twelve wire gauzes, one fourth of an inch apart. The smoke which ascends will deposite its soot on the wires, and their temperature will, by their proximity to the fire, be sufficiently high to effect its combustion.

404. *Others, again, have proposed* to fix some permanent apparatus in the flue, by means of which a brush could be carried from top to bottom at any time. We have seen contrivances of this kind already; but it is too soon to pronounce upon their general efficiency. However, it seems quite possible in a new house to contrive the flues so that they might be swept at any time by the ordinary servants, or by any person engaged to do such work. The flues should be circular, and bricks have been made for building them so.

CHAPTER III.

ON THE VARIOUS KINDS OF FUEL.

SECT. I.—WOOD.

405. *The most ancient fuel was undoubtedly wood.* It appears that most countries, before they were peopled, were in great part covered with forests, as we see in America at present; and the cutting down these to make room for cultivation supplied, at first, the necessary fuel. In ancient times, wood was universally used in England for this purpose, as it still is on a great part of the continent of Europe. The destruction of our forests by various causes began to be felt as a serious evil about three centuries ago, when, fortunately, the introduction of coal more than compensated for their loss. From the abundance and cheapness of the latter substance, wood is now little employed as fuel in the British Isles, except by the poorest classes, who in some parts still depend upon the refuse of plantations. In many parts of France wood is regularly planted for the fire, where the natural woods have been long since consumed. In Britain this is seldom practised; nor would it, perhaps, be generally useful while coal can be had; though some have thought it desirable to do so, for the benefit of the poor.

406. *When wood is used as fuel for warming apartments*, it is cut into certain lengths and laid across an iron apparatus, called here *dogs*, or *andirons*, formerly universally used in our mansions, but which now are rarely to be met with.

Wood makes a very cheerful fire, from its abundant and bright flame; but it consumes quickly, and requires often renewing: on this account it is expensive, and the labour necessary to prepare it is also very considerable. It is likewise bulky to store, and must be kept very dry. It has the advantage of kindling readily, but affords an unsteady heat. For some purposes its flame is convenient, and for others the contrary.

407. *Wood, when examined minutely*, is seen to consist of longitudinal fibres, finer than hair, the interstices between which are filled up with a cellular substance, or tissue, the disposition of which varies somewhat in the different species of trees. This disposition is seen in any section across the tree.

408. *The elementary principles of which all vegetables consist* will be particularly described in Chap. VII., Book VII., to which we refer the reader. We may here observe, that wood, like all vegetable matter, is composed of carbon, hydrogen, and oxygen; which, when it is decomposed by burning, are separated from each other, and are reunited in other proportions, which constitute the products of the combustion.

409. *When wood is burning*, the hydrogen unites with a small portion of the oxygen, forming the gas called *light carbonated hydrogen*, and it is the combustion of this which constitutes the flame. (The nature of combustion has been described in Chap. II., Book II.; and that of flame will be treated of fully in Chap. I., Book IV.) A small quantity of other gases are generated by the combustion, as carbonic acid and carbonic oxyde, by the union of some of the carbon with some of the oxygen; but these are ineffective in the production of light and heat. When all these volatile products are given off by the combustion, if the farther burning of the wood is stifled, charcoal would remain, which consists of the woody fibres alone, deprived of all the principles except the carbon, which, being less volatile than the hydrogen and oxygen, remains, preserving the original form of the wood. This charcoal, however, is capable of being burned likewise; for if the combustion be suffered to proceed, it will all disappear, its carbon uniting to the oxygen of the atmosphere, and thus producing carbonic acid. As wood contains, besides the principles we have enumerated, a small quantity of earths, alkalies, metallic substances, &c., incapable of combustion, these remain as ashes. (See Chap. II., Book XXII., "Laundry.") When wood is burned in a chimney, the current of air up the chimney becomes diminished when the combustion is nearly at an end; and though the embers of the charcoal still retain a state of ignition until they become reduced to ashes, yet as the fire becomes weaker the draught up the flue becomes less, and then there is danger of the carbonic oxyde and carbonic acid gas that are generated from the charcoal coming into the apartment, their weight being greater than that of common air. A fire in this state, therefore, cannot be considered as healthy to sit over, and the air of the apartment must become vitiated. But wood can give off no sulphuretted hydrogen, as it has no sulphur, like coal. During the combustion, there is, likewise, some

pyroligneous acid formed, the vapour of which gives that penetrating effect peculiar to wood smoke.

410. *The heavy and dense woods give the greatest heat*, burn the longest, and have the densest charcoal. To the dense woods belong the oak, beech, alder, hazel, birch, and elm: to the soft, the fir, the pine of different sorts, larch, linden, willow, and poplar. Clement and Desormes found that woods give out heat in proportion to the relative quantities of their carbon.

Under like dryness and weight, different woods are found to afford equal degrees of heat in combustion. The effect of wood in producing heat depends much upon its dryness.

Count Rumford showed that unseasoned wood contains one third of water; and much of the heat is expended in converting this into steam or vapour, which escapes up the chimney. With his improved boilers he made twenty pounds of ice-cold water boil with one pound of dry pine wood: the same wood unseasoned produced an effect less by one seventh.

The quantity of moisture in newly-felled wood amounts to from 20 to 50 per cent.; birch contains 30, oak 35, beech and pine 39, alder 41, fir 45. Wood felled for twelve months still contains from 20 to 25 per cent. of water; there is never less than 10 per cent. present, even when it has been kept long in a dry place; and though it be dried in a strong heat, it will often absorb from 10 to 12 per cent. of water. If it be too strongly dried, its heating powers are impaired.

Trees that have attained their maturity without passing into decay are the best for the production of heat when employed as fuel. Thus, the value of an elm of one hundred years is, for this purpose, better than one of thirty years, in the proportion of twelve to nine; and of ash of one hundred years to one of thirty years, as fifteen to eleven. When trees begin to decay, their value as fuel rapidly diminishes.

411. *The wood used in heating ovens for baking bread* generally consists of small branches of trees, made into what are called fagots.

A fagot is a bundle of any sort of small wood, consisting of the spray and shoots of trees of three or four years old, tied closely up together by means of a *withe*, which is a name given to very small splittings of willow, hazel, or some other pliable wood, twisted. They are mostly made up from the cuttings or thinnings of underwoods and coppices, and the prunings or superfluous branches of a spray of hedges. They give a clear and rapid heat, and they are sold to those bakers or others who use wood. In making up these bundles, the workmen trim off the superfluous spreading branches from the sides and ends, which gives them a neater appearance. The trimmings are put into the middle of the fagot. Formerly, when wood was the fuel of the country, and before coal was used, fagots were regularly kept as a part of the stock of fuel. As they kindle readily, and give a great quantity of flame, they are used where a strong and quick heat is required; but, as they burn away proportionally soon, they are not fit for an ordinary durable fire: in conjunction with other wood, they supply the means of producing any degree of increase of heat that may be wanted. They require to be very dry. On the Continent, where the apartments are heated by means of stoves, branches of this kind are much employed in them.

412. *Cones of the fir tribe*, particularly of the pine, which are found dropped on the ground in the autumn and winter, are extremely inflammable; in the north of Italy, these are collected, and much used for kindling their wood fires, as they are easily set on a blaze by the flame of a candle, and they cause the fire to burn briskly.

413. *Wood is analyzed by distillation in close vessels*, as in the process for making pyroligneous acid. The first product that comes over is the watery vapour or steam from the moisture in the wood, mixed with pyroligneous acid. Next follows a considerable evolution of gas, which is inflammable, being hydrogen combined with a small portion of carbon, not usually above half the density of coal gas, and not affording nearly so strong a light. Then follows carbonic oxyde, a gas consisting of carbon, with its minimum of oxygen. But though the gas from the combustion of wood, containing less carbon than that from coal, gives less light, it gives more heat than coal gas; and hence we see the reason why the flame of wood is so much more efficacious in making a vessel boil than the flame of coal. The purer the hydrogen, the greater affinity it has for oxygen, and, therefore, the more rapidly it burns: the addition of carbon to the hydrogen retards the combustion and diminishes the heat, though the light is increased by it. That the most intense heat results from the attraction of oxygen and hydrogen for each other is shown by the hydro-oxygen blow-pipe, in which a stream of each gas coming together is ignited at the point of contact. The fuel that contains most hydrogen will give out the greatest quantity of heat. But to produce the greatest effect of fuel, it is necessary that it should be put in close vessels, and that the heat evolved shall be carried to one spot, instead of being suffered to radiate and become dissipated by escaping into the atmosphere. This is the cause of the great heat produced by a few sticks in such culinary vessels as the "conjurors," or in closed fireplaces, and of the great waste by boiling kettles over an open fire. See "Culinary Apparatus."

414. *There are many cases in domestic economy where wood, cut into small pieces*, is the cheapest fuel, a circumstance too much neglected. Count Rumford was of this opinion; and states, that in very small fires for some purposes, it is the most cleanly, the most convenient, and most manageable fuel. He found by experience that any given quantity of wood, burned in a closed fireplace, gives very near three times as much heat as it would give if reduced to charcoal, and burned in the same fireplace. Another great advantage of using wood for closed fireplaces, is the quantity of flame it affords, and the facility with which it may be kindled and put out by a damper.

SECT. II.—CHARCOAL.

415. Charcoal is extremely valuable as a fuel, and possesses peculiar properties. It is the carbonaceous part of wood, or the carbon alone which remains after the other elements, the oxygen and hydrogen, have been volatilized by combustion. Charcoal is not any part of the wood altered by burning, according to the vulgar notion; but it existed in the wood originally, and is only made apparent by the escape of the other ingredients.

416. *When a branch of charcoal is examined by the microscope*, it exhibits the structure of the tree in its living state; for what is the woody fibre of the plant, and which may be called its skeleton, is deprived, by having been burned, of all but its carbon, which still remains in its original position. Numerous pores may be seen disposed in order, and traversing the branch lengthways, which are the vessels of the plant; so that there is no piece of charcoal but might be blown through. This may be best seen by breaking off a piece short. In a piece the eighteenth part of an inch thick, Dr. Hooke reckoned 150 pores; whence he concludes that in a piece of charcoal of an inch in diameter, there are no less than 5,724,000 pores, which agrees with what is known respecting the amazing minuteness of the tubes of which plants consist.

417. *Although the charcoal remains after the rest of the wood is consumed by combustion, it is itself, as is well known, a combustible body;* and the reason why it does not disappear like the rest of the wood when burned is, that carbon is less combustible than hydrogen, and that, in the process of carbonizing, time was not allowed for the combustion of the carbon, nor a sufficiency of atmospheric air, the fire being checked and smothered just in time to prevent its destruction. If, however, this charcoal, so preserved, be again exposed to the action of fire, with free access of air, it will burn, that is, it will unite with the oxygen of the atmosphere, giving out heat, and forming a gas, which is the carbonic acid gas, or the ordinary vapour of charcoal, the suffocating properties of which are so dangerous.

It must not be supposed, however, that charcoal consists of pure carbon; for it retains a small quantity of some other principles in the wood that were not capable of being volatilized, and those appear in the ashes of charcoal when it is burned.

418. *The ashes of charcoal consist of several of the earths*, as clay, silex, and lime, together with some alkali or potash: sometimes even a minute portion of iron is found. The ashes of charcoal, or of wood, for it is the same thing, are much esteemed by agriculturists as a manure for land, as also for washing and scouring, and from them potash is obtained. (See Book XII., "On the Laundry.")

419. *In the combustion of charcoal* no flame can appear, for the flame of burning wood arises, as we have shown, from the hydrogen of the vegetable; but, as that has been dissipated by the first combustion, no more remains in the charcoal to cause flame.

Whether the blackness of charcoal is the natural hue of the element, carbon, is uncertain, for absolutely pure carbon is unknown to us in a detached state, except it be, as is supposed, crystallized in the diamond.

420. *The common process of making charcoal in this country is as follows:* Men accustomed to the business cut and cord the wood in winter: charcoal-burning takes place during the summer months, and is, for the most part, carried on in the woods, to save the expense of carriage. After it has been felled, the timber is cut into billets, and when it is become sufficiently dry, the process of converting it into charcoal is begun by raising a plot of ground a little higher than the surrounding surface, and bringing it to a slightly convex form by beating it: thus a hard, dry, and solid floor is formed. In the centre of this area is placed a circle of sticks, adjoining each other, and composing a vertical hollow cylinder from three to four inches in diameter, and about six feet high. Round this interior cylinder are ranged successive circles formed by pieces from one to ten inches in diameter: several flues are formed through the pile, and the whole is so constructed, that it kindles in a short time, and burns very equally.

The outermost circle is composed of brushwood and chips. When the pyramidal pile measures from twenty to thirty feet in diameter, it is sufficiently large. It would burn out, when kindled, into a vast blaze, and be quickly consumed to ashes, but that a coating is now laid on of turf, the grassy side being next to the wood; and dry earth is heaped up round the bottom of the pile, and well rammed, in order to prevent the admission of air. Three or four screens, formed of large hurdles well stuffed with brushwood, are also prepared, in order to protect the pile from the violence of the wind. All the preparations being now completed, the pile is kindled by dropping lighted chips down the

hollow cylinder in the centre, which, in proportion as they are consumed, are supplied by others during the first three or four days, at the end of which period the kindling of the pile is completed. The top of the cylinder is now closed, and a row of holes, each about two inches in diameter, is pierced at the base of the pile, by which the requisite quantity of air is supplied, and a passage is afforded for the smoke and vapour. Whenever the white watery smoke is succeeded by thin blue and transparent smoke, which may take place in about a fortnight, it is reckoned that all the watery and volatile part is dissipated, and that the burning of the coaly matter is commencing; therefore the fire must be stopped. The holes are now all closed in succession, and the pile is covered over with earth as accurately as possible, till the fire is completely extinguished, going out for want of air. The pile is now allowed to cool, which requires many days; for charcoal, being a very bad conductor of heat, the pile remains long red hot in the centre, and if opened in this state, will immediately burn with fury.

421. *In France they use a great deal of charcoal for many purposes, particularly in their kitchens.* In the forest of Benon, near Rochelle, great attention is paid to the manufacture of it. It is there made from the black oak, and is sold above 20 per cent. dearer than any other. It is made in heaps covered with turf, nearly in the manner described above. An improvement has lately been made in its manufacture, by filling in all the interstices of the heap of wood to be charged with powdered charcoal. The quality of the fuel made in this manner is equal to cylinder charcoal, and the quantity is one fifth by weight greater than in the usual method.

422. *Charcoal for ordinary purposes is made in the open air, as above described;* but when it is required of greater purity than common, as for the manufacture of gunpowder, *the charring is performed in closed iron cylinders*, fixed in masonry over a grate: this is furnished with a door at one end that can be accurately closed, and terminating in the other in a curved pipe. The cylinder is filled with pieces of the willow, elder, and other aquatic woods. When the fire is lighted, the volatile products escape though the pipe, and the charcoal remains in the cylinder. Lately, the making of charcoal in closed vessels has been converted into profit by collecting pyroligneous acid in the process, from which vinegar is made. But it is remarkable that, though the charcoal made in this manner is so superior for making gunpowder, yet it is not so well calculated for some other purposes. It is not of half the specific gravity of the charcoal which is made out of doors in the common way, covered up with turf; the makers of iron, particularly, will not buy it.

423. *Charcoal varies in its quality*, not only according to the most or less judicious modes of manufacture, but likewise according to the nature of the wood it is made from. The hardest woods, as oak and beech, make the best charcoal for fuel; while that from the softer woods, as the willow and the alder, is most proper for making gunpowder, crayons, polishing copper plates, toothpowder, and medical purposes. That commonly sold in London is pile burned, and made of oak, beech, and hazel: sometimes willow charcoal is mixed with it.

424. *The great convenience of charcoal for ordinary operations* has rendered its employment almost quite necessary in some of the processes of cooking, particularly in the French manner. By its means a fire may be made in any part of the kitchen, as it gives no smoke, kindles readily, and burns with very little draught of air, continuing till the whole is burned out.

It burns away very quickly, requires frequent renewal, and is very expensive; but is the best fuel where a very regular heat is required, as in stewing. It is particularly useful in some furnaces, as it gives a strong heat, and makes no clinkers.

425. *Although charcoal gives no smoke, it should never be forgotten that its combustion cannot go on without the formation of carbonic acid gas*, the dangerous nature of which has been explained. This gas, indeed, being heavier than atmospheric air, generally occupies the lowest place in the apartment, and is, perhaps, almost always below the level of ordinary breathing; yet a certain quantity cannot fail to mingle with the air, and render this unwholesome to breathe. The air arising from charcoal when burning is as clear and invisible as common air; but this very circumstance prevents us from perceiving its presence, and it may, therefore, prove highly dangerous before we are aware of it. The air rising from coal or any other fuel likewise contains much carbonic acid; but the smoke, which always accompanies it, gives warning, and becomes highly disagreeable before it is dangerous. This is not the case with the vapour of burning charcoal; hence so many fatal accidents from its use in confined places, where there is no flue. The first sensation, when it has become dangerous, is a slight sense of weakness: the limbs seem to require a little attention to prevent falling. A slight giddiness, accompanied by a distinct feeling of a flush or glow on the face and neck, succeeds. Soon after, the person becomes drowsy, wishes to sit down, but commonly falls on the floor, insensible of all about him, and breathes strong, snoring as in apoplexy. If the person is alarmed in time, and escapes into the open air, he is commonly seized with a violent headache, which gradually abates. But when the effect is completed, as above described, death very soon ensues, unless relief be obtained. In short, the

effect is suffocation. The most prudent treatment in a case or accident of this kind is to take off a quantity of blood immediately, and throw cold water on the head repeatedly. A strong stimulus, such as hartshorn, applied to the feet, has also a very good effect.

426. *Besides its use as a fuel, charcoal possesses several properties* which qualify it to render very important services in the arts. Its indestructibility renders charring the outside of wood that is to be driven into the ground a very useful practice. Its tendency to absorb various gases makes it very serviceable in preventing putrefaction; it is accordingly one of the best preservers of meat for a short time, and will even remove a slight taint when meat has been kept too long. (See "Preservation of Food.") It makes an excellent toothpowder.

Its nonconducting property renders it very useful on many occasions for confining heat. It has also the property of freeing many liquors from their empyreumatic flavour, and also of depriving them of colour.

Sect. III.—Coal.

427. This substance, sometimes distinguished by the term *pit-coal*, and now the most important fuel in the world, has not been in use above three centuries. Vast strata of it are found deep-seated in the earth, and it is raised by the regular operations of mining. Notwithstanding its situation would appear to present great difficulties to the supposition, yet it is now completely ascertained that it has been formed from vast collections of *vegetable matter* that have got together, and been subjected to the action of water, compression, and other causes, but in what particular manner time has wrought so great a change is not distinctly understood. The analysis of coal is not very different from that of vegetable matter in general: each consists chiefly of carbon, hydrogen, and oxygen; only the latter exists in much smaller proportion in coal than in recent vegetables, and coal contains a little ammonia, sulphur, and a good deal of earthy matter. The hydrogen of coals is exhibited in the gas-light, and the carbon in the coke, which remains after the distillation of the gas. (See "Illumination by Coal Gas," Chap. V., Book IV.)

The superiority of coal over every other combustible, for domestic as well as many other purposes, is now generally acknowledged. The chief objection to it seems to be the smoke it sends out, which blackens or stains the surrounding objects to a great degree, and even in our apartments.

428. *The coal of every different coal-field, almost of every pit, differs in some particulars*; but we may conveniently class them all into three kinds: 1. Caking coals, called also bituminous coals. 2. Open burning, or noncaking coals. 3. Anthracite, or nonbituminous coal.

429. *Caking coals* are those which soften with the heat, and partly melt like pitch or bitumen, throwing out at the same time jets of very bright flame. Small coal of this kind will, by melting, run together, and bind into a hard mass that requires being broken by the poker to admit fresh air, otherwise it would not continue to burn. Caking coal is the kind that is mostly used in London, and it is brought chiefly from Northumberland and Durham, where there are extensive coal mines. The whole goes by the name of *Newcastle coals*, that being the place where the greatest quantity is shipped; and it is sometimes called *sea coal*, being brought by sea. The best of the Newcastle coals for domestic use is from the pits called *Wallsend:* they burn with a very white and brilliant flame, and do not cake so hard as some others. The small coal of this kind is what is used by the blacksmiths. The *Tanfield moor* coals are the strongest, and cake the hardest: they are mostly used in furnaces.

Cannel coal is a much rarer variety of the bituminous sort, that burns with a very bright white flame, and is employed by the poorer people in the north for affording light instead of candles, "cannel" being the mode of pronouncing "candle" in the north. It does not soil the fingers, and is sometimes turned on the lathe into various ornaments. When put into the fire it is apt to split and fly out, but is sometimes mixed with other coal, on account of the flame which it affords. Scotch coal is generally of a large kind: some of it is a strong, well-burning coal, but not nearly so bituminous as the Newcastle. It is scarcely known in London.

430. *Open-burning coal*, called also *cherry coal*, is much less bituminous than the Newcastle, gives much flame and ashes, but does not cake. The Shropshire coal is of this kind. This coal, which gives a white ash, is convenient for burning in a chamber in summer, because a very small fire will keep in; whereas with a strong coal the fire requires frequent attention. From this circumstance the cherry coal is often very useful to an invalid.

431. *Anthracite* is a coal very different in its properties from all the others. It consists almost wholly of carbon, without any, or at least very little, hydrogen: consequently it gives no flame nor smoke; nor can it afford any gas. It is, indeed, nearly a mineral charcoal, and differs little from coke, which it resembles in most of its properties, though very unlike in appearance, for it is smooth in its fracture, and has a high

shining lustre, superior to that of the richest Newcastle coal, and does not soil the fingers. It is difficult to kindle, and cannot be burned in an open grate without an admixture of bituminous or Newcastle coal; but it may be easily burned in close stoves or furnaces. Abundance of it is found in South Wales, and it begins now to be brought to London for stoves. It is likewise used for drying malt, and in breweries, distilleries, &c.

Anthracite is known by several other names, as *blind coal*, *culm*, *stone coal*, *Swansea coal*, and *glance coal*. This coal is also dug at Kilkenny in Ireland; and vast quantities are found in Pennsylvania, where it has been for some time employed in the iron manufacture, for which purpose it is now likewise used in South Wales.

432. *When coals are dug they are liable to be broken more or less;* hence there is always a quantity of fragments, which constitute the small coal. When the coal is bituminous, and of the best kind, this small coal is still useful, as it will cake together, and is particularly desirable for the blacksmith's forge; but when the coal is little bituminous, as the Shropshire, this small coal does not cake, and it is then of little value. It is customary in all coal to separate the large from the small by screening; and the small is sold at a much lower rate, under the name of *slack*. It is no uncommon thing for dishonest dealers to mix some of this slack with good coals, though some of it is scarcely combustible.

433. *The price of coals to the consumers in London* is said to be considerably enhanced by a class of middle men, who are called in the trade *Brass-plate coal merchants*. These consist principally of merchants' clerks, gentlemen's servants, and others, who have no wharf of their own, but merely receive orders and transmit them to some true coal merchant, who sends in the coal from his wharf: all that is effected by the brass-plate coal merchant being to receive a handsome commission for his agency, with this attending circumstance, that the coals are likely to be of an inferior quality, with the means of redress being rendered more difficult. In ordering coals, therefore, it would be prudent not to deal with any but those who actually keep wharves of their own.

434. *To derive the greatest advantage from open coal fires*, it is necessary not only that the fuel should be well selected, but that the fire should be properly managed. It is not sufficient that the coal burns well; for it may do so without giving so much heat to the apartment as if it were managed differently. Here, again, we shall find that by resorting to a few principles we shall comprehend more clearly what is the best practice.

We explained above that air is essential to combustion, and that it is by the decomposition of the air during this process that heat is evolved: it follows from this that to throw out the most heat, the fuel should be so arranged, that the air shall have free access to every part; care should, therefore, be taken that the coals do not lie in too compact a body, but that interstices should be left that the air may penetrate through the fire.

435. *Lighting a fire* may appear so simple and well-known a process, that it may be thought quite superfluous to give any directions respecting it; and yet how often do we suffer the inconvenience of seeing the fire go out soon after it has been lighted? Perhaps few circumstances try one's patience more than to witness abortive attempts at lighting a fire. To do this methodically, a basket should be provided, with a separation into two parts; one for paper or wood shavings, the other for wood split and cut into proper lengths. If the paper is put on the bottom of the grate, as is frequently done, and the wood in too large pieces, the iron of the grate abstracts the heat so much from the commencing flame that it will not have strength enough to kindle the wood; or if it does take fire, the combustion is too feeble to set fire to the coals that are heaped upon it. The better way is to have some pieces of very choice inflammable coal, and to lay a few pieces at first on the bottom bars, but without covering them entirely; then lay on the paper or shavings, then the wood, and on that some pieces of round coal of the size of eggs, and no small coal: when the whole is kindled, let it burn up before any more coal is added. If the small coal be put on at first, it is sure to choke the fire by filling up the vacancies, and preventing the air from having access to the centre. The coal laid at the bottom will take fire by the time that the wood is nearly burned out, and will, by its flame, keep the fire alight. If a fire is thus laid and kindled, there is no reason why it should go out, and it ought to burn up with certainty when left to itself. Some have recommended to have kindling balls made of coal, mixed with some very inflammable substance; but as these have not come into use, it will do very well to select some of the best ordinary coals, that take fire very readily, which may be had of the coal merchants, and kept for the purpose of lighting fires: the trouble of this will not be great, and may, in some situations, prevent much annoyance. It has often been condemned as a bad plan to throw too much coals on the fire at a time, as by this a great deal of the hydrogen is distilled off, and escapes up the chimney without catching fire, which is absolute waste. That some hydrogen, which we may call the most inflammable part of the coal, does generally escape unburned in open fires, we may convince ourselves of by holding a piece of lighted paper in some of the smoke which is rising from the fire where there is no flame; we shall perceive that sometimes a flame will instantly appear, owing

to the escaping hydrogen being set fire to. To manage a fire in the best manner, little hydrogen should escape up the flue, otherwise there is a loss of fuel. We may here repeat, that the manner in which open fires warm apartments is by the radiant heat almost entirely. We should, therefore, prevent the front of the fire from being clogged with unburned coals, while the combustion is going on in the centre; the front should be of a glowing red, since that is the condition in which the fire throws out most radiant heat. To promote this, some persons have employed brick balls to put into the fire, and when these are well managed, they do assist in throwing out radiant heat by becoming red hot; but they require much care and attention, as they are apt to collect together and choke up the fire, thus doing more harm than good: we cannot, therefore, recommend them. Much of the comfort and advantage of open fires depend upon the quality of the coals: they should not be too bituminous, otherwise they cake so fast as to require frequent stirring and breaking. Bad coals leave too much ashes, and are not inflammable enough; also, though cheap, they are far from being economical; and we may here repeat the advantage of having the fire burn against brick instead of iron. In short, to arrange a fire well requires some judgment, and is interesting to those who can perceive it as a constant exemplification of the chemical laws of nature.

436. *Coals are at present sold by weight*; and by a late act of Parliament, under a penalty of £10 to the carman, and £20 to the vender, a perfect machine must be carried for weighing coals. The correctness of any machine may be easily tried by putting a 56lb. weight into each scale, and see if it fairly balances. By the same act it is ordered, that machines and weights should be kept at the different watchhouses and police stations, for weighing any coals about which there may be any dispute, and power is extended to any two justices of peace to appoint other places for the same purpose.

When the coals are shot down into the coal cellar through the circular aperture, they form a conical heap under it; and, as is always the case with loose materials, the largest pieces roll farthest down on the outside of the heap, the smallest occupying the top. Were the coals to be used from this heap as it is formed, the result would be, that all the large pieces of coal would be used first, and towards the last there would be only small coals. To prevent this inconvenience, a person, called a *trimmer*, is sent by the coal merchant, whose business it is to mix the small and large together properly by throwing the whole into the end of the vault; but, unless the trimmer be looked after, he is very apt to neglect doing this properly, his only object too often being to keep them within the door of the coal cellar, without caring whether they are mixed or not, although this is of much consequence to their burning well. This man is paid 3*d*. per ton by the coal merchant; and it is proper for some one to see that he does his duty.

437. *The complete decomposition of coal* is explained in Chapter II., Book II., when treating on "Combustion;" and in Chapter V., Book IV., "Gas light."

Sect. IV.—Coke.

438. *Coke is prepared from coal by depriving it of its hydrogen*; consequently, coke can give neither flame nor smoke. It is, in fact, to coal, what charcoal is compared to wood, and is prepared by a similar process. When made on the great scale, for smelting iron, the coal is laid in heaps, covered over with earth and clay, and set fire to: a smothering combustion, having very little access of air, causes the hydrogen to separate from the coal, without the carbonaceous part being consumed, as in the making of charcoal; and, when this is effected, the fire is put out, and what remains is coke. A great quantity of this combustible, and particularly that which is chiefly employed for domestic purposes in London, is what remains in the iron retorts after the gas has been extracted from the coal for illumination; and this is superior for domestic use to that made in the large way for smelting.

439. *Coke has the advantage of giving out an intense radiant heat, without any smoke*, and is therefore particularly convenient for many purposes. It is, in fact, a mineral charcoal, being the carbonaceous part of the vegetable substance from which the coal was formed; but the woody structure is no longer visible, as in charcoal. It is likewise more dense than charcoal, containing more carbon in the same compass, and therefore capable of affording a longer continued heat. From the clearness with which it burns, and the intensity of its radiant heat, it is excellent for certain operations of the cook, where a bright, clear fire is wanted, as broiling, roasting, &c.; but it is difficult to kindle, and does not answer well in a grate without an admixture of coal; but these two together make the strongest fire. Coke, however, leaves a great deal of ashes. It is also convenient to mix with coals that are very bituminous, to prevent their caking together too much. Some attention is required in trying any particular kind of fuel, as each demands a peculiar management. Coke, when used in an open fire, should be broken of the size of a goose egg, and laid on the top of the fire, when it has burned well up; the pieces will collect the radiant heat that would have escaped up the chimney, and soon themselves become red hot, in which state alone they are effective. Care should be taken that they do not get in front of the fire before they are red hot, as they will only obstruct the rays of heat.

440. *There is some difference in the density, and, consequently, in the strength of the coke,* according to the kind of coal from which it is produced, or the mode of preparing it. The heaviest gives the most heat, and will last longest; but that which is shining and light will burn most readily.

441. *It is a notion with some that coke is more sulphurous than coal;* but this is impossible, since the very object of coking coal for smelting iron is to deprive it of its sulphur, which is dissipated in the coking; and the same effect takes place when it is left after the coal gas has been taken from the coal. Coke burned by itself has, however, all the bad qualities of charcoal, of giving out carbonic acid gas, which, if the current or draught up the chimney is not sufficient, will fall down into the apartment; but while it is burning in a fireplace there is no danger of this, as the current upward carries the carbonic acid along with it.

442. *In very cold weather,* putting some coke on the fire is a decided improvement, from the greater heat thrown out than can be given by coal alone. Coke is also, in many cases, economical, when properly managed. The heating power of good coke is to that of pit-coal as 75 to 69.

Sect. V.—Peat.

443. *Peat, sometimes called turf, but improperly,* is a fuel much employed in many countries; although in England, from the abundance of coal, a much superior substance, it is little esteemed. Nevertheless, it is the only fuel which the poorer classes can procure in parts of the north and west of Scotland, and a great part of Ireland. In many parts of Holland there is no other fuel; and in several districts of France, Germany, and other kingdoms of Europe, where coal and wood are scarce, the poorer inhabitants burn nothing but peat.

444. *Peat is a vegetable production* comparatively recent. In low grounds, and sometimes even on the flat summits of hills, where the water cannot run off, certain plants peculiar to such situations accumulate, and grow on each other. When these decay, they are converted into the substance called peat; and sometimes this growth is increased by fallen trees, which, by rotting, add to the peaty matter. If a portion of peat be examined, it will be found to consist almost entirely of the roots, stems, and leaves, of small plants matted together, and changed into a dark-brown substance. The accumulation of peat in some countries, called *peat mosses* and *peat bogs*, are sometimes many miles in extent. Their depth varies from a few feet to several yards, and it is certain that they have required many ages for their growth; but peat still continues to form when circumstances are favourable. The substance of peat is soft when in the peat moss, and is easily cut with a spade, by which it is formed into pieces of the shape of large bricks: these are exposed to the air; and, when they are dried, they are very firm and inflammable.

445. *Peat, as a fuel, being loose and spongy in its texture, compared with more solid kinds,* is not so fit to be employed for the production of strong heat, as it is too bulky, and burns away too fast; but, when we desire to keep up a long-continued and extremely gentle heat, we can scarcely use anything better than peat. There is a very great difference in the quality of this fuel. Some of it is very light and spongy, of a brown colour, appearing to consist of a mass of the fibrous roots of plants and dead leaves, &c. This kind burns readily, but consumes rapidly. The best peat is compact and heavy, of a brownish black colour, with scarcely any vestiges of its vegetable origin remaining. This last is an excellent fuel, gives a steady heat, though mild and gentle, with a brilliant white flame, and does not require so much attention as wood; but, when lighted, preserves the fire a long time, and, when red hot, bears to be moved about: still, it consumes much faster than coal.

446. *The smoke of peat* is copious and penetrating, and affects the eyes like the smoke of wood. It gives an odour disagreeable to those who are not accustomed to it, owing to the pyroligneous acid which is disengaged. As this smoke occupies the upper part of the cottages where chiefly it is burned, it is less felt by sitting down. It likewise imparts a peculiar empyreumatic smell to everything it comes in contact with, which adheres with great obstinacy; but this smoke is well adapted for curing some kinds of meat and fish, imparting to them a peculiar flavour, much esteemed.

447. *The best and densest peat is generally found at the bottom* of the peat mosses, being older, and subjected to most pressure. In farm-houses and cottages, peat is usually burned upon the hearth, which cannot be done with coal; and when it is dry, good, and properly disposed or built up, it blazes and makes a cheerful fire, which, from its low situation on the ground, diffuses a great deal of warmth. The best kind burns very well in a grate, but the quantity of ashes it makes renders it inconvenient in this way; whereas, on the hearth, the ashes, instead of being inconvenient, are extremely useful to poor people in various processes of their cookery. Hot peat ashes are excellent for roasting fish, eggs, &c.; and likewise for stewing, and any kind of cookery that requires a mild heat. In this respect it approaches to charcoal.

448. *Peat is not well adapted for furnaces,* or any fires where the draught is very quick

as it consumes too fast. It has been calculated by Clement and Desormes that it gives only one fifth of the heat afforded by an equal weight of charcoal.

449. *A process has lately been tried*, which promises to render peat more available as fuel. The peat is, when soft, put into a powerful press, by which the water is expelled, and the parts brought close together. One man can, by a lever, work the press, and the operation requires only a few seconds. By this the peat is reduced to one third of its original bulk, and rendered so compact as to approach the properties of coal. This method has been for some time practised in France, and likewise in Ireland.

450. *Charred peat*. The smoke of peat being exceedingly acrid and disagreeable, it is in some countries charred before it is used as fuel. The Dutch, who use a great deal of peat, char what they put into the pans with which they keep their feet warm at home and at church. It is first burned in the kitchen, and when it is red hot, they take it off the fire, and stifle it in an earthen pot by covering it up with a wet cloth. This charred peat they also use for cooking, as the French do the charcoal of wood in stoves, or cast iron kettles. When peat has been treated in this manner, it is found to contain 40 per cent. of charcoal, and is sufficiently strong as a fuel to be employed in smelting works. But it possesses one inconvenience: if laid in a heap, it is apt to take fire of itself, on which account it is forbidden to keep a store of it in towns. A very simple process for charring peat is given in the Farmer's Mag., vol. xvii. "Take a dozen or fifteen peats, and put them upon the top of the kitchen fire, upon edge: they will soon draw up the coal fire, and become red hot in a short time: after being turned about once or twice, and done with smoking, they are charred, and may be removed to the stores: if more is wanted, put on another supply of peat, and manage it as above."

By this plan a supply of the best charred peat may be obtained, while, at the same time, the kitchen fire is kept up. This charred peat, when burned, is free from smoke and sulphureous vapours, and is much fitter for warming beds than coal, which always has some sulphur: the charred peat gives out no smell; but it is to be observed, that it has all the dangerous effects of charcoal, which we have described.

SECT. VI.—PREPARED FUEL.

451. In England, we are so accustomed to a good coal fire, that we do not perceive that inelegance in its appearance, which has sometimes struck those who have been used to burn wood. Count Rumford, in one of his early essays, observes, that "nothing surely was ever more dirty, inelegant, and disgusting, than a common coal fire."

Much of this, however, it must be confessed, is now done away with among us, by the neatness of the grates in which the fuel is burned, and the great care which is taken to keep our firesides clean. No doubt improvements may still be made by a careful selection of the kind of coals, and by these being broken nearly to certain sizes, and mixed judiciously with a proper proportion of smaller, which is separated by screens.

452. *In countries where fuel is scarce and dear*, attempts are made to cause what they have to go as far as possible. In several parts of Germany and Flanders, particularly in the Duchies of Juliers and Bergen, where coals are used as fuel, though not plentiful, and of an inferior quality, they are always prepared before they are burned. They are pounded to powder, mixed up with an equal weight of clay, and a sufficient quantity of water to form the whole into a mass, which is kneaded together and formed into square cakes, which are afterward well dried, and kept in a dry place for use; and it has been found by long experience that the expense attending this preparation is amply repaid by the improvement of the fuel. The coals thus mixed with clay not only burn longer, but give much more heat than when they are burned in their crude state.

But in England, where coals are abundant and labour is dear, we cannot expect that much pains will be taken on this subject for the mere purpose of economy: probably its complete study will be reserved for posterity, when our coal fields begin to be exhausted. Nevertheless, attempts have been made to produce here a better or a more economical fuel than coal; and several patents have been taken out for this purpose. The mixture of small coal with clay has been tried, and formed into square pieces; but though those burn very well and give out much heat, they are objectionable, from the large quantity of ashes which they necessarily leave.

On visiting the coal districts, it is impossible not to see with regret enormous quantities of small coal, called *slack*, lying near the coal shafts, exposed to the weather and totally neglected: one might suppose that it was possible to convert this to some useful purpose, perhaps to make a cheap fuel for various purposes; and the writer of this article, in his "Lectures on Geology," in 1827, at Birmingham, Dudley, and the environs, pointed out distinctly the neglect of this material, and suggested modes in which it might be rendered available as fuel.

A variety of mixtures have since been tried, of small coal with clay, bitumen, tanner's waste, peat, sawdust, and other inflammable substances. Some of them promise to be advantageous, particularly in steam-engines for navigation.

453. *Cow dung* is used as a fuel in many parts of the world; even in some parts of Britain, where better fuel is scarce, and the people very poor. When thoroughly dried

it burns slowly, forming a remarkable contrast to thorns and furze. Dr. Clarke, in his Travels, informs us, that the common fuel used by the inhabitants of Egypt is prepared from a mixture of camel's dung, mud, and straw, or the stalks of any other plants: these ingredients being mixed as a paste, they collect it into balls, which are flattened upon the walls of their huts for drying in the sun, and made into circular cakes. The same custom prevails in Persia and Arabia, where wood is scarce.

454. *Sea wrack*, or *fucus*, forms a tribe of marine plants, which, when cut off the rocks, and driven ashore by tides and storms, and dried, is used for fuel in some places on the seacoast where a better material is not to be had, or is too expensive, as in parts of Sweden.

Sect. VII.—Liquid Fuel.

455. *The fluid inflammables*, as fat and essential oils, bitumens, &c., so much used for light, are occasionally employed also as fuel for giving heat; although, in this country, on account of their great price, they are used only on a small scale, and where a gentle or slight degree of heat is sufficient.

456. *Alcohol*, when pure and free from water, is as convenient and manageable a fuel for producing a moderate and gentle heat as can be desired. It is burned in a lamp, and its flame is perfectly clear, of a pale blue colour, and free from any kind of soot: it can easily be made to burn slower or faster, and to produce less or more heat, by changing the size or number of the wicks upon which it burns; for as long as these are fed with spirit in a proper manner, they continue to yield flame of precisely the same strength. The cotton, or other materials of which the wick is composed, is not scorched or consumed in the least, because the spirit in which it is constantly soaked is incapable of becoming hotter than 174°, as above that temperature it boils and is evaporated; and that heat is not sufficient to inflame the wick. It is the vapour only that rises and is inflamed: the outer parts of the flame are the hottest, being most remote from the wick, and where only the combustion is going on, in consequence of communication and contact with the air. At the same time, as the alcohol is totally volatile, it does not leave any fixed matter, which, by being accumulated on the wick, might render it foul and fill up its pores. The wick, therefore, continues to imbibe the spirit as freely, after some time, as it did at the first. These qualities, however, belong only to a spirit that is pure. If it be weak, and contain water, the water, being less volatile than the spirit, does not evaporate so fast from the wick as the more spirituous part; and the wick becomes, after some time, so much soaked with water, that it does not imbibe the spirit properly: hence the flame becomes weaker, and at last is extinguished, the remains of the spirit having too much water to burn. Were it not for the expense, therefore, we should always use pure alcohol: but common spirit of wine is generally employed, and is found extremely useful for table teakettles, apparatus for making coffee, heating a little water, and a variety of similar purposes. The products of the combustion are only carbonic acid and water; and, owing to the combination with oxygen, the weight of the water produced, but which dissolves in the air, exceeds that of the alcohol consumed.

Spirit of wine is probably the most portable kind of fuel, and was employed in this way by Sir Edward (then Captain) Parry in his expedition undertaken with a view to reach the North Pole. His account of it runs thus: "Our fuel consisted of spirits of wine, of which two pints formed our daily allowance, the cocoa being cooked in an iron boiler over a shallow iron lamp, with seven wicks; a simple apparatus, which answered our purpose remarkably well. We usually found one pint of the spirits of wine sufficient for preparing our breakfast, that is, for heating twenty-eight pints of water, though it always commenced from the temperature of 32°. If the weather was fair and calm, that quantity of fuel brought it to the boiling point in about an hour and a quarter; but more generally the wicks began to go out before it had reached 200°. This, however, made a very comfortable meal to persons situated as we were."—*Parry's Voyage*.

457. *Fat, oil, or tallow gives a higher temperature than spirits of wine*, but a common wick produces much smoke and soot. A cluster of several small wicks somewhat diminishes the evil. A lamp of this kind, and of considerable size, is occasionally employed in portable apparatus for cooking; and, when confined, the heat is sufficient to dress meat in various ways. The Greenlanders and Esquimaux, in Baffin's Bay, have no other fire or method of producing heat than by means of lamps with fish oil, and wicks of moss. Over such lamps their cooking vessel of potstone is suspended, containing the flesh of deer, seals, or fish. By employing an Argand's lamp, the smoke is consumed; and chemists find this to be a very convenient method of applying a considerable degree of heat in small distillations and other processes. In this case the chimney of the lamp is made of copper instead of glass.

458. *Oil of turpentine mixed with water and alcohol* has been tried with success for burning in a lamp for the purpose of giving light and heat. An apparatus for this purpose was contrived by Mr. Morey in the United States, and mentioned favourably in Silliman's Journal. The mixture is put into a tin cylinder, which is heated by means of a common

lamp. The vapours from the mixture are made to issue through small holes at the top, where they are inflamed, and this flame may be employed in warming a building, cooking, or for any similar purpose.

459. *Oil of turpentine mixed with fat oil* has likewise been employed where a very large quantity of flame has been required, as in contrivances for heating water.

SECT. VIII.—COAL GAS.

460. *Among modern improvements* may be enumerated the application of coal gas as a fuel. Although it is chiefly employed for illumination, it is likewise on some occasions successfully used for giving heat, and has been already adverted to in Book II., "On Warming Buildings." In our description of culinary apparatus, we shall mention some instances where it has been tried with this view. It is continually employed in manufactories as a substitute for the oil used in the lamps for soldering.

SECT. IX.—ECONOMY OF FUEL, AND COMPARATIVE HEATING POWERS OF THE VARIOUS KINDS.

461. In some parts of the world fuel is so plentiful, that the study of economy in this article is little worthy of attention. In the wilds of America, or some other new settlements, wood costs nothing but the trouble of felling and splitting, and the consumption of it is sometimes a convenience; but in countries long inhabited, and where cultivation has destroyed the natural growth of timber, this kind of fuel has become expensive. In England, in many districts where coal is worked, and the price of it is low, much attempt at economizing may seem almost superfluous; but that is not the case in all parts of the kingdom, and the expense of carriage being considerable, would give importance to all inventions that tend to reduce the necessary consumption.

462. *In the fireplaces of our apartments and kitchens, as they were constructed forty years ago*, the waste of fuel was excessive. Although we are under infinite obligations to Count Rumford for the plain practical rules for effecting the greatest saving in fuel, through which numerous improvements have been effected, yet this subject is far from being generally understood; nor can it be, until the philosophical principles upon which it depends are more particularly studied than they are at present by those who are concerned.

463. *In our descriptions of the modes of warming and ventilating our domestic edifices, and of fitting up kitchens* and the various apparatus for culinary purposes, the reader will find some remarks on this subject, and examples of the best modes at present employed of economizing fuel; for all directions with this view, to be useful, should be accompanied by application to practice. Some there are who, having no taste for economy of any kind, have endeavoured to turn the economy of fuel into ridicule, and to represent it as not worth the pains and time bestowed upon it; but it should be observed, that, even although there may be some truth in this remark as applied to particular instances, yet it is one thing to establish a principle, and another to determine when and how far it is useful to apply this principle. All experiments demonstrating how any effect can be produced by a diminution of trouble or expense must be of value as matter of science, although the propriety and occasion of adopting the improvement made must be determined by various circumstances. We cannot, therefore, consider any successful attempt to economize fuel as entirely without value, in a general view, since one improvement frequently leads to another, perhaps of greater value. We feel it necessary, however, to put our readers upon their guard against the numerous puffs and quacking advertisements respecting pretended savings, by the adoption of newly-contrived apparatus for warming and cooking. Many of these contrivances are altogether ineffective; others are of so complicated a construction, and so liable to be out of order, that no saving can compensate for the trouble attending them, and the difficulty of teaching servants their use, together with the expense of repairs and alterations. Those who wish to engage in experiments, have a taste for such inventions, and who can manage them themselves, may make great and real improvements. But to economize fuel, an article of such vast importance, and to apply it in the most judicious manner, the nature and properties of the various combustibles must be studied, as well as the philosophical principles upon which combustion depends, without which all endeavours at improvement must be useless; and it will also be necessary to obtain accurate information respecting what has already been done, lest inventions should be made, and supposed to be original, that have been already long known.

464. *With respect to the quantity of heat that may be obtained from the several combustibles* when a comparison is made, they should all be burned in the same way. One method employed for this comparison has been to ascertain the quantities of ice that could be melted by a pound of fuel, which is thus stated:

One pound of	*Melts of ice*	*One pound of*	*Melts of ice*
Good coal	90 lbs.	Carburetted hydrogen	85 lbs.
Coke	84	Olive oil	120
Charcoal of wood	95	Wax	110
Wood	32	Tallow	105
Peat	19	Sulphur	25
Hydrogen gas	370		

The heating effects of fuel will likewise depend very much upon the apparatus employed, the subject to be acted upon, and the quality of the fuel. Thus, if a boiler is to be heated, the fuel that gives out flame will be most effectual by striking upon the bottom of the boiler, whereas, in heating apartments by open fires, it is the steady radiant heat that we depend upon, and not the flame: therefore, strong Newcastle coal, when brought to a red heat, and still more, coke, will be more effectual than Staffordshire coal, that blazes, but which is soon obscured by ashes; and both these will warm more effectually than wood that has ceased to blaze.

465. *Every kind of fuel should be kept as dry as possible.* When improperly exposed to the weather, or put into damp places, a great deal of its material when burning is employed in converting the water it contains into vapour, which escapes up the chimney, carrying with it the heat that was necessary for its conversion, and which might have been employed in giving warmth where it was wanted. Count Rumford found that unseasoned wood contained about one third of its weight of water, and, consequently, produced much less effect in boiling water than the same quantity of dry wood. The same remark will apply to coals; but there are other reasons why it is sometimes useful to damp small coal slightly. When perfectly dry, they are apt to run to waste among the ashes. A little dampness causes the dust of caking coals to adhere together till the heat fuses it into a mass, which is then broken up by the poker.

SECT. X.—SPONTANEOUS COMBUSTION.

466. *Serious accidents, and often considerable conflagrations*, have frequently been occasioned by substances taking fire of themselves; and it is proper to know what materials are liable to spontaneous inflammation. The following are examples:

467. *Sulphur and iron filings* moistened and buried in the ground, or laid in a heap, will inflame in a few days.

468. *Iron pyrites*, composed of sulphur and iron, found naturally in coals, when laid in a heap in the coal mines, often takes fire, and burns for a long time, and ships freighted with coal have been set fire to from the coal containing too much of this substance.

469. *Chips of wood impregnated with turpentine*, if laid together in a heap, will burst into a flame in twenty or thirty hours. This has been observed in manufactories of oil of turpentine, when the chips, which the raw turpentine brought from America contains, have been separated by straining.

470. *The mixture used at theatres for a red light* has ignited spontaneously when a paper parcel containing a pound of it was laid by on a shelf. This powder consists of nitrate of strontium, sulphur, chlorate of potash, sulphuret of antimony, and a little lampblack.

471. *Peat, when charred*, is very apt to take fire of itself.

472. *Wool that is much oiled*, and laid by in quantities, has been known to inflame spontaneously.

473. *Tow with lampblack and oil* is extremely liable to spontaneous inflammation. Both these last have frequently been the cause of places where they were kept being set fire to, without the cause having been at first suspected.

BOOK III.

ON VENTILATION.

CHAPTER I.

CHEMICAL PRINCIPLES OF VENTILATION.

474. *Perhaps there is no subject of equal importance, the knowledge of which is less generally diffused than that of Ventilation.* Though the fact is now generally admitted, that pure air is essential to health, yet in what that purity consists, and how it is to be preserved or attained, are considerations too much neglected. We will endeavour to place this interesting subject in a clear point of view; but we must observe, that, to put in practice the best modes of ventilation, it is necessary to be familiar with its theoretical principles.

475. *It is only since the modern discoveries in pneumatic chemistry, respecting the composition of atmospheric air*, and the changes effected in it by respiration, that rational ideas have been entertained on this subject. When mankind were in utter ignorance as to the nature of air, of the manner in which it supports life, and of the causes which destroy its salubrity, we cannot wonder that the necessity for a strict attention to ventilation was not very obvious. Practically, indeed, to a certain extent, it was known that there was a difference between good and bad air; but, as the nature of that difference was not ascertained, nor in what way air becomes vitiated, it was impossible to know the means of preventing it; but now that science has developed the necessary facts, we may expect that this valuable part of domestic economy will meet with due attention.

476. *When treating on combustion, we showed* that the air of our atmosphere is not, as was formerly supposed, a simple element, but that it is essentially composed of several kinds of air mixed together, viz., oxygen gas and nitrogen gas, with a small proportion of carbonic acid gas, together with aqueous vapour. All these gases are highly important in the general economy of nature; but our present object is to point out in what way they contribute to the support of animal life.

477. *Air is essential to the existence of every living being;* nor can either animal or vegetable come to life if this element be entirely excluded. In the act of breathing or respiration, atmospheric air is inhaled or drawn into the lungs, which process is termed *inspiration.* After a very short time the air is again sent out by *expiration,* when it is found to have been remarkably altered in its properties. The particular nature of the alteration can only be explained by reference to pneumatic chemistry. It appears that the lungs decompose the atmospheric air, and separate it into two principal constituent gases; retaining one part, the oxygen, for the support of life, and rejecting another part which is unfitted for this purpose. Since the oxygen is more particularly necessary for maintaining the vital principle, on the first discovery of the chemical constitution of the atmosphere, it received the name of *vital air*—a term now laid aside, or only occasionally employed. The fact of the chemical change in the air, by breathing it, is easily ascertained by examining it previous to its being taken into the lungs, and afterward when given out. One hundred parts of common or atmospheric air consist of about twenty parts of oxygen gas, seventy-nine parts of nitrogen gas, and about one of carbonic acid gas. These proportions of the first two are very nearly constant in whatever part of the world the air is examined, whether at land or at sea, in doors or out of doors; but the proportion of carbonic acid is variable according to the place: if it exceed one fifth it will be fatal to the animals that breathe it.

478. *The air, when expelled from the lungs,* is found not only to have lost a considerable portion of its oxygen, but to have received a large proportion of carbonic acid gas, and likewise of aqueous vapour: the quantity of nitrogen being diminished in a small degree only. That much watery vapour is contained in the breath is familiar to every one, from the common practice of moistening substances by breathing upon them; and that carbonic acid is given out at the same time, will appear from the following experiment:

Quicklime is pure lime obtained by driving off the carbonic acid by heat from carbonate of lime; and this quicklime has a strong attraction for carbonic acid when presented to it again. Dissolve some quicklime in water by letting it remain in it for about a day; the clear solution is called *lime water.* Put some lime water into a glass vessel, and having provided a small glass tube, or, for want of it, a straw, place the end of the tube in the water, and impel the breath through it by blowing for a little time. The water will soon begin to exhibit a milky turbidness, an effect which is to be explained in the following manner: Though quicklime is soluble in water, carbonate of lime is not: now the lime attracts the carbonic acid thrown out from the lungs, and is thus converted into the insoluble carbonate, which, in consequence of its insolubility, appears as a white powder like chalk, producing the milky appearance through its suspension in the water. This effect appears to be the result of one of nature's laws, that we shall thus part with a quantity of carbon which has been taken in with our food, but which is more than sufficient for the animal economy.

479. *We come now to consider the oxygenous part of the atmospheric air, a great part of which we observed was retained by the lungs.* By experiments varied in many ways, it is found that a small quantity only of oxygen is contained in the air which is expired. When treating on the combustion of fuel, we showed that oxygen was necessary to its support, and that fuel would not burn in air which had already served this purpose. The action of the respiratory organs appear to produce an effect very analogous to what we perceive in combustion: the oxygen is abstracted, and hence it must follow that air which has served to support life by being breathed will be as unfit for maintaining life or flame as that which has passed through the fire and has supported flame. This, accordingly, we find to be the case.

480. *If we were to breathe the same air over and over again,* at every inspiration, we should abstract a fresh portion of oxygen from it, until at last, having entirely consumed the oxygenous part, the remainder would be incapable of maintaining either life or flame. This fact has been put beyond all doubt by experiments which are perfectly demonstrative. A mouse was confined in a glass jar quite closed, so that no air could get either out or in; and, consequently, the animal confined was obliged to breathe the same air continually. It remained for a little time without feeling any inconvenience, since the quantity of air in the jar was at first sufficient to supply the necessary proportion of oxygen; but after a time, as this diminished, and the animal was obliged to inhale nitrogen, and the oxygen being reduced to too small a quantity for the continuance of life, the animal appeared to be gradually more and more oppressed, and at length died of suffocation. A lighted taper was now introduced into the air in which the mouse had died, and it was instantly extinguished; showing that the oxygen had been entirely, or almost entirely,

abstracted; an effect which was proved by an accurate chemical examination of the remaining air.

This instructive experiment will serve perfectly to illustrate the effect produced by being too long shut up in small or confined rooms, without sufficient ventilation or change of air.

481. *We shall not here attempt to go farther into the subject of animal Physiology, nor trace the part which oxygen acts in the support of life,* than briefly to notice, that in the well-known circulation of the blood from the heart to the superficial parts of the body, by means of the arteries, and back again to the heart through the veins, it is observed that the blood which had become dark-coloured in its passage through the veins, has, by being brought into contact with the fresh air inspired by the lungs, its florid red restored before it is received back into the heart to renew the circulation; and thus it is concluded that it is by means of the oxygen that its vital properties are kept up.

If, therefore, we attempt to breathe any gas containing no oxygen, the consequence will be suffocation, from the want of the supply of that element which is essential during every minute of our existence. It must now be evident, from what has just been said, that, if we continue to breathe a limited quantity of air over and over again, we must by degrees deprive it of the whole of its oxygenous principle, and, since what remains would be unfit for the support of life, we must then die like the mouse in the experiment.

482. *Before the nature of atmospheric air, and the important part which it performs in respiration, and the preservation of life and health, were properly understood,* it is not surprising that many practices and customs existed extremely destructive to health, without the cause being perceived; and at present it is lamentable to observe the consequences which still frequently result from ignorance in regard to this subject. Persons often sleep or pass a long time in small and confined rooms, where the quantity of air contained in them must have had its vital principle nearly exhausted or so much reduced as no longer to be fit for the purposes of healthy respiration.

483. *Instances almost innumerable might be adduced of serious and even fatal effects* proceeding from similar causes. We shall mention one which has also been quoted lately on the same subject by Dr. Coombe. In the Edinburgh Advertiser of 1st March, 1833, we are informed that "a distressing circumstance was discovered on Wednesday forenoon, on board the Magnus Troil, Shetland trader, Captain Ganson, lying at Leith. The master and mate, who are brothers, went, as usual, on Tuesday night to sleep in the cabin of the vessel, but not appearing at the customary hour in the morning, the crew thought they had merely slept beyond their time. A little time having elapsed, they were repeatedly called; but no answer being returned, one of the men went into the cabin, where he found the two brothers almost dead through suffocation. It is thought that they had shut the companion and skylight so close, that they had, during the night, exhausted the whole of the vital air necessary for respiration. Medical aid was procured." Captain Ganson, however, it appears, did not recover, but died convulsed on the following morning. A similar instance is stated by the same author to have occurred on board a French ship in the harbour of Jersey, where the captain and mate lost their lives by suffocation, in consequence of sleeping in a very small cabin, the door of which was so carefully shut, that any access of fresh air was completely prevented; and accidents such as these are probably more frequent than is generally supposed. But instances so fatal seldom occur, because, however confined apartments may be, there are few where there are not some openings or cracks through which the air is changed in some degree. The most dreadful example on record of the destructive consequence of an inadequate supply of atmospherical air, exists in the horrible fate of 146 Englishmen, who, in 1756, were imprisoned in a small room only 18 feet square, called the Black Hole of Calcutta. There were only two very small windows in this place, and as both were on the same side, ventilation was impossible. Soon after the door was closed, they began to experience heat accompanied by intense thirst; within a short time many became delirious, and at the end of six hours, 96 were relieved by death from their torments. In the morning only twenty-three were found alive, reduced to the last extremity, and of these a few only ultimately survived.

484. *It must be obvious that the greater the number of persons who assemble in any apartment, the more quickly they must consume the oxygen of the air contained in it;* and if the supply of fresh air be not equal to the consumption, it must be continually more and more deteriorated, until at last it becomes highly deleterious. In such places, the candles and lamps also contribute to destroy the vital portion of the air; for we have shown that there is a very strong analogy between combustion and respiration, in each case oxygen being consumed, and carbonic acid given out. In small and confined rooms, therefore, many lamps or candles are particularly injurious and unhealthy.

485. *A very simple experiment will show that lights consume the oxygenous or vital part of the air.* Put some water into a dish, and having fixed a short taper upon a flat piece of cork or wood, light it and set it to swim upon the water; then invert a tall bell-glass over the taper. At first the light will burn perfectly well; but, by degrees, it will soon grow

dim, and at last will go out, having consumed all the oxygen, and the air remaining in the jar being only nitrogen. The air will not appear at first to be diminished, because what remains, being expanded by the heat, it occupies as much space as before; but when the air cools and contracts, the water will rise up in the glass, and show how much air has been destroyed by the combustion. If the bell-glass is so contrived that another lighted taper could be introduced into the remaining air, the latter would be found incapable of supporting the flame. From a variety of chemical experiments, which cannot be detailed in this place, it is easy to demonstrate that it is the oxygen alone, and not the nitrogen, which is consumed by the flame: an animal introduced into the residual air will die immediately.

486. *It is a beautiful provision of nature*, that, even without our being aware of it, we are prevented from immediately inhaling again the impure and poisonous air which we throw out in breathing. When it issues from the chest, being heated nearly to the temperature of the body, or 98°, it is dilated, and, consequently, rendered specifically lighter than the surrounding atmosphere: hence it instantly ascends, as wood from the bottom of water; and before the next inspiration, it is removed out of the way, giving place to purer air. But this natural ventilation, as it may be called, is complete only while we are in the open air: when we are shut up in an apartment, the vitiated air rises, but it is stopped at the ceiling, and preserves its lofty situation only so long as its elevated temperature remains; when it has gradually given out its surplus heat to the walls of the room, it becomes of the same density as the rest of the air, mingles with it, and thus descends to our level, where we are liable to inhale a part of it again, together with the purer portion. From this it is evident that the upper part of a room, next the ceiling, is the place where, in general, the worst air is collected, and, of course, that this is the place for letting it out: but it must be recollected that no air can make its escape from the room except an equal quantity enter to supply its place; and it follows that there should be a contrivance somewhere for the admission of fresh air, and the lower part of a room is the proper situation for this purpose. This last observation will be reconsidered when we describe the practical methods to be adopted in ventilation.

487. *It is evident, also, from what we have said, that in crowded rooms*, if no judicious means are employed for getting rid of the bad, and the introduction of good air, that what has been exhaled by one person will be breathed by another, the poisonous air which each person gives out mingling with the mass, and vitiating it. Such an atmosphere, consisting of good and bad air mixed together, may not be immediately dangerous, although extremely unhealthy: the degree of its insalubrity must depend upon the number of persons collected together, and the more or less confined nature of the place.

488. *It is calculated that each person consumes, on an average, five cubic feet of air in an hour*, or, in other words, deprives oxygen of such a quantity of atmospheric air. If a hundred persons, therefore, were confined in a room 30 feet long, 25 broad, and 30 high, the whole air in that apartment, consisting of 22,500 cubic feet, unless renewed, would be noxious and dangerous to breathe in about four hours and a half. Is it wonderful, then, that crowded rooms, heated and close, where routs and assemblies are held, theatres, and other places of public amusement, and even churches, should be so pernicious to the health of those who frequent them, where proper ventilation is neglected? For besides the destruction of oxygen, or vital air, the great increase of carbonic acid gas, together with the noxious effluvia from other causes, tend to vitiate the air in a very great degree. The additional deterioration of the air, produced by many lights, will be alluded to afterward.

489. *From our having stated that it is the oxygen alone which supports life in respiration*, and that air deficient in oxygen is unhealthy, it may perhaps be supposed that an atmosphere of pure oxygen, or one having more than its usual quantity, would be eminently salubrious. This, however, is not the case; an increase of the usual proportion of this gas, which can be artificially given, is found to give too strong a stimulus to the system, and fever would be the result: we should, in fact, burn out too soon, like a wooden splinter in a jar of oxygen.

490. *Health demands that the usual and natural proportion in the constituents of air should be neither increased nor diminished*, except in a very minute degree; and by the most wonderful contrivance of Providence, the proportion is preserved nearly the same, at all times and in all places, as we have already stated. And here we may perhaps be excused for departing for an instant from what is strictly our subject, to point out a remarkable proof of wise design. The carbonic acid, produced by combustion of all kinds, and by the respiration of animals, and which might in time vitiate the whole atmosphere, is consumed by the vegetable creation, to which it serves as a pabulum or food, in the same manner as oxygen does to animals. Nay, more; vegetables, at the same time that they attract and retain carbonic acid, give out, in sunshine, pure oxygen gas. Thus, vegetables improve the atmosphere when it has been deteriorated by animals.

But notwithstanding the consumption of oxygen, or the vital principle of the air, by combustion and respiration, and its rapid abstraction in confined apartments and other places in doors, this is not so considerable as to affect the general atmosphere, or the air

out of doors, very sensibly: still we know from the above reasoning that it must suffer from the above processes, were it not renewed.

491. *When atmospheric air was first discovered to be composed of oxygen and nitrogen, and that the former was the principal supporter of life,* it was very naturally supposed that the air of those countries which were known to be very healthy would be found, upon analysis, to contain more than the usual proportion of oxygen; and, on the contrary, that those which were unhealthy would be deficient in that principle. Upon making careful experiments, however, with a view to determine whether this was the case, the result did not prove it; for portions of air being taken from the open fields, from hills, from the sea-side, from towns, even from prisons, were examined, and the proportion of oxygen was found to be the same in all. It is evident, then, that the salubrity or insalubrity of air out of doors does not depend upon the proportions of the elementary principles, oxygen and nitrogen, they being the some everywhere, but rather upon the absence or addition of some other invisible substances, some of which may be of a highly deleterious nature. Thus carbonic acid, sulphuretted hydrogen, or carburetted hydrogen may abound, or even some other gaseous matters; or unknown vapours may be mingled through the air of particular places, rendering them unhealthy. It is well known that some of these noxious gases are disengaged from marshes, stagnant waters, common sewers, and all places where animal or vegetable substances are in a state of putrefaction; and other deadly poisons may be diffused through the atmosphere, which the skill of the chemist does not enable him to detect.

492. *The subject of ventilation is not confined to the dwelling-house alone, but extends to the air of cities and towns.* It is scarcely necessary to allude to the innumerable sources of deleterious vapours, exhalations, odours, and gases, that are constantly generated in cities where there is a deficiency in sewers, pavements, water, and general habits of order and cleanliness. This subject, fortunately, has attracted much attention, and we may be excused for not pointing out many facts that are now beginning to be pretty generally known; but the subject is too important to be entirely passed over. History informs us that pestilence, the scourge of society, has prevailed frequently and virulently in ages, countries, and even districts, in which cleanliness and the proper ventilation of houses have been little considered. Without entering on the various theories respecting the exciting causes of pestilential disease, a little research will afford sufficient proof, that want of cleanliness has been a principal cause of their aggravation and rapid diffusion. If we read the account of our own metropolis during the last calamitous visitation of the plague, in 1665, and compare it with its present state, we may convince ourselves that our present exemption from the recurrence of such an evil is secured to us on more grounds than those of precautionary laws of quarantine. At that period in the history of this vast city, the streets were narrow, the houses projecting in the upper stories, and the spaces between them crowded with large signs hung across, and checking the free circulation of air, essential to the health of the inhabitants. To the miasma constantly engendered, and rising up from the open drains and neglected sewers, were added those caused by the fermentation of heaps of rubbish and garbage ejected from every house, and which the indolent inhabitants could scarcely be compelled to remove. Nature has provided means for carrying off impure air, and replacing it with such as is suited to animal respiration; but here its intentions were defeated, both by the construction of the buildings, and the habits of the people. Nor were the interior arrangements better calculated to promote health. The windows were small, the rooms low, the floors made of clay strewed over with straw or rushes, among which lay rejected fragments of food and dirt of all kinds. Ventilation was totally disregarded, and the result was a perpetual recurrence of fevers, from which the English, at that time, were scarcely ever free. In this condition of things, infectious diseases spread with a dreadful rapidity, and the history of the plague by Defoe exhibits the condition of the people in frightful colours. It is almost needless to advert to the improvements that have probably banished pestilence in its aggravated form, and rendered our metropolis one of the most healthy on the globe. The principal of these are, undoubtedly, well-constructed sewers, and an abundant supply of water; streets wide, well paved, and kept, if not as clean as they might be, yet far more so than formerly; large sashes to open, wooden floors, with a frequent renewal of the papering and painting of the interior, and open chimney fireplaces. It is not intended here to attribute the existence of pestilence, cholera, and other violent diseases to want of cleanliness alone; they may originate in natural causes, though unknown to us, but it appears from evidence that they have produced the most fatal ravages where indolent, filthy, and disorderly habits prevailed.

Though the improved state of knowledge in this country has produced the most happy effects in averting the most desolating and wide-spreading evils of disease, still we should recollect that the same causes, though acting upon a smaller scale, will always tend to produce more or less derangement of health.

493. *The great importance of ventilation must be perceived,* when it is considered that, although respiration may proceed, and life exist for a time, in cases where the atmospheric air is vitiated to a considerable degree, yet, as pure air is essential to the full en-

joyment of health, every degree of vitiation of it must be prejudicial, although this effect may not be perceived immediately. It has been well observed, that "in the great majority of situations to which man is exposed in social life, it is the continued or reiterated application of less powerful causes which gradually, and often imperceptibly, unless to the vigilant eye, effects the change, and ruins the constitution before danger is dreamed of; and hence, the great mass of human ailments is of slow growth and slow progress."

494. *Ventilation, as the means of preventing disease,* is not only necessary in the habitations of the poorer classes, as far as their health alone is concerned, but the middle and higher ranks of the community have an almost equal interest in securing good ventilation wherever the habitations of human beings are to be found, more particularly where they are crowded together in towns and villages; since disease, once generated by the neglect of ventilation and cleanliness, spreads its frightful ravages far beyond the boundaries of filth and wretchedness, and falls, as a punishment, upon those whose duty it was to have been the guardians of the labouring poor. The late visitation of the cholera has, perhaps, done more to place this subject in its true light than volumes of writing could have effected; and there cannot be a doubt but that the whitewashing, cleaning, and ventilating of the houses of the poor, during the prevalence of the epidemic, did much to check its progress.

CHAPTER II.

PRACTICE OF VENTILATION.

495. Having now investigated briefly the principal causes which deteriorate the air, or render it unhealthy and unfit for the purposes of respiration, it is necessary that we should turn our attention to the means of preventing this evil, or of correcting it when it has occurred. Prevention being always better than cure, the importance of understanding the causes which injure the salubrity of the air cannot be overrated, since this alone can enable us to avoid them. To remove the evil when it has already taken place is more difficult, but still partly within our means.

496. *It is an error to suppose that air can become unwholesome merely by being stagnant.* Pure air, like pure water, never changes of itself, however long it may be kept; but it may have impurities mingled with it, arising from various sources, without these being easily discoverable. In this manner air may be contaminated if shut up, an effect which, indeed, usually takes place, it being the great receptacle for a variety of invisible effluviæ and vapours that rise from the earth, or from surrounding substances. The most prudent thing, therefore, is not to use air that has been long pent up, but to change it for the fresh air of the atmosphere.

497. *It has been imagined that fire has the power of purifying air* by burning and destroying the noxious particles with which it may be contaminated; and as a remnant of this idea still exists in the minds of some persons, it is necessary to show the fallacy of it. Fire, instead of purifying air by burning anything in it, actually vitiates the air which has passed through it, as we have shown, by its abstracting the only portion of the air that is useful in supporting life: burned air, therefore, or what has gone through the fire, instead of being purified, is rendered poisonous. What has led to this error has been the observing that the air of confined places is often improved by lighting a fire in them; but this improvement is solely owing to the current or circulation of air that is produced, and the consequent introduction of fresh air: if the fire was made in a confined place, where no change or current of air could happen, as in a room without a chimney, so far from purifying the air, it would render it doubly noxious.

498. *Fumigating pastiles* are preparations formed of odoriferous resins and other substances to be burned in an apartment to perfume the air, either as a luxury, or to overcome some disagreeable odour. It was supposed, formerly, that the burning of aromatic, resinous, and balsamic substances, had the property of purifying tainted air, and destroying contagious miasma; but they are now considered as wholly inefficacious for this purpose, and though they may conceal offensive exhalations, and render them less discoverable by the senses, they offer only a deceitful security. Various mixtures are employed for making pastiles; but they all contain charcoal mixed with fragrant materials, as benzoin, balsam of Peru, storax, gum benjamin, oil of cloves, and nutmegs, myrrh, nitre, mastich, labdanum, &c.; and though these odoriferous gums produce an agreeable perfume, yet the vapours of the charcoal, instead of purifying the air, tend to increase its unwholesomeness by giving out carbonic acid.

499. *Since, when air has lost that constituent by which it supports life, there are no means of restoring it,* it follows that our only resource is to get rid of the foul air, and to replace it by what is fresh and good. The mode of effecting this necessary change of the air of apartments constitutes properly what is termed "ventilation," a term derived from the Latin word signifying *wind*, the motion or current of air furnishing the most obvious method of accomplishing this object.

500. *Before we proceed, we must beg the reader's attention to what we have stated respecting the air being a substance as much as any other fluid*; and that we cannot possibly cause any air to go out from a room, except an equal quantity come in at another opening: for it is a law of nature, that every place which, in common language, is *said to be empty*, is, and must be, always *full of air:* if we were to draw the air out from an apartment through some aperture by means of a machine, more air from without would force itself in by means of the whole pressure of the atmosphere to supply its place, if not through an equal aperture, yet through all the innumerable minute crevices that exist in the walls, doors, windows, floor, &c.; and if these were absolutely tight, so that no air could come in, then it would be impossible for any air to go out. This fact is sometimes evinced in the bad draught of a chimney of a small apartment in which the work has been very well executed, or well finished, as it is called; that is, with all the joints very close, so as to let in no draughts. The reason of this is obvious; though air that has served the combustion has been rendered lighter by the heat, and therefore has a strong tendency to go up the chimney, yet it cannot move and be succeeded by more air to the fire, except an equal quantity of air can enter the room by some openings, large or small, to supply its place, otherwise the room would be emptied of air by such a current making its exit: but nature has willed that every place *must* be full of air; hence the absolute necessity for openings in some part of the room for the admission of fresh air, in order that a fire may burn. This necessity is generally overlooked by those who are unacquainted with the philosophy of this subject, the material nature of air, and the manner in which it presses in to fill every space. It is in vain, therefore, to think of stopping up every crevice capable of occasioning a draught: a draught *must* exist where a fire of any kind burns in an apartment; and the study must be to contrive that the air shall be admitted where and how it will be the least inconvenient.

501. *Where a fire is burning in the chimney of an apartment, a certain degree of ventilation is going on constantly*, and must go on, of itself, without the thought or attention of any person; and this, as we have stated above, is an immense advantage in open chimney fireplaces, which, it is desirable, should be properly understood and appreciated. It is obvious that the current of air necessary to feed the fire produces a continual change of all that part of the air which is below the level of the mantel; but this cannot happen without a partial change, at least, of what is above that level; for, as we observed, the air vitiated by respiration and the burning of lights, first ascends to the ceiling in consequence of being warm, and, although it must remain imprisoned there for a time, if there are no apertures for its escape, yet by being cooled gradually, it descends and mixes with the rest of the air of the room, and it then more or less falls into the current of air rushing towards the fire.

Among the various kinds of air with which that of our apartments is contaminated, some are of different degrees of specific gravity from atmospheric air; and it might therefore be supposed that we might find them at different heights. It might be imagined that the carbonic acid, from its greater specific gravity when cooled, occupies the lower part of the room, though, while warm as just escaped by the breath, it had risen to the ceiling. But this complete separation from each other of the different gases never takes place, for it is the nature of gases very soon to diffuse themselves and commingle, and the warm and cold portions soon change places by becoming of equal temperature; at least this is their constant tendency, and we cannot draw any line of separation between them, as if they were so many strata. All the time, therefore, while a fire is burning in an apartment, the air is constantly, though slowly, changing, by one part passing through the fire and going up the chimney flue, while fresh air to supply its place is forcing in at all the crevices in the apartment. Whether this change is sufficient, must depend upon the number of persons in the room who destroy the vital part of the air, and also upon the number of lights, which act in the same way.

502. *If the vitiated air be not removed with sufficient rapidity by the draught of the chimney alone*, then some other mode will be necessary in addition. Formerly, in England, the dwelling-rooms of the middle and lower classes were so low, that the air which was injured by respiration could scarcely ascend above the heads of the inhabitants, who were, therefore, always immersed in an impure atmosphere: it is to be observed, that this must be the constant effect of low apartments, and is an evil which attaches to the habitations of our poor of the present day, and often to the bedchambers of the wealthy. A room only seven feet high cannot possibly be healthy to live in, as then there is not space for the expired air, which consequently becomes mixed with the purer air of the lower part of the room, and is breathed over again.

As our best houses are now constructed, with the rooms lofty, and the sashes made to open at top and at bottom, or, as it is called, *double hung*, ventilation becomes comparatively easy. The warm vitiated air ascending to the ceiling, finds there sufficient space above our heads, till it cools and mixes gradually with the rest, as we have shown; and if we wish to change the air more completely, we have only to pull down a small part of the upper sash, that the hot air near the ceiling may escape. But this

escape of foul air will not always take place while a fire is burning, except we attend to some circumstances. Should the aperture made by pulling down the top sash be greater than the area of the crevices in the apartments from which the fire was supplied, some cold air will come in by the window to supply the fire, instead of hot air going out, and the effect of this will be unpleasant. It is necessary, therefore, that some other apertures, at the lower part of the room, should furnish this necessary supply of air to the fire, and permit the warm to go off: opening a door for a short time will effect this, or lifting up the lower part of a sash. But this mode of ventilation, though perfectly effectual and easy, cannot with convenience be always well applied while persons are in the room, on account of the draughts of cold air which must enter, though it is quite sufficient whenever the room is empty; and this principle being understood, it is not difficult to modify to suit it to most occasions. Dwelling-rooms which are only occupied during short periods, and thoroughly ventilated by the windows between those periods, seldom require any other systematic ventilation than what we have just described. French sashes, which open like folding-doors, are the best for this purpose where they can be introduced, as the whole extent of the window can be opened; whereas with double hung sashes only one half of the window can be open, though this half may consist of one portion at top and another at bottom.

503. *The necessity for good ventilation in the basement story and offices* of every house must appear evident, when we reflect how the air in the lower story ascends up the staircases, and that if there are any noxious effluvia disengaged below, they are sure to contaminate the air of the whole house. It is in vain, therefore, that great pains are bestowed upon the upper apartments, if the lower ones are neglected. We believe there are few houses that do not suffer more or less from this cause, and that many are rendered really unhealthy, though the occupiers never suspect the truth itself, nor the cause of it. It should be a constant practice of the principals to make regular descents into these lower regions, and to examine with their own eyes the condition of things, in a case in which not merely their comfort, but their health, and that of their family, are seriously concerned. Frequent thorough cleaning and scrubbing, whitewashing and painting, with regular visits, would do much to improve the atmosphere of every mansion, and care should be taken that every place should have proper openings for a free circulation of air.

504. *Good ventilation is nowhere more important, although nowhere more neglected, than in our bedchambers.* The bad effect of sleeping in small and close rooms has been already mentioned; to which we may likewise add, that of having thick curtains drawn close round the bed, which confine the air that has been exhaled, surrounding us with an impure atmosphere. Provision should be made for a continual change of air in the apartment during the night, by the escape of the heated and foul air, and the introduction of cool and fresh air. The first may be effected by some aperture at the top of the room; perhaps keeping the top sash open for about an inch may be sufficient: of course, care must be taken that the fresh air brought in at the lower part of the room does not act as a draught striking upon the bed, but that it enters by small apertures, and diffuses itself as quickly as possible; and likewise that there may be the means of regulating the quantity according to circumstances. If the temperature of the fresh air can be regulated, it will be better.

[The practice of sleeping in illy ventilated rooms, and especially with curtains drawn closely around our beds, would scarcely be persisted in if we did but reflect on the effect of thus depriving ourselves of pure air during the hours of sleep. Air that has been once breathed is rendered unfit for animal life until it has been again purified; it being composed of two gases, termed oxygen and nitrogen; the first of these is the great agent in respiration and combustion, and is often called vital air; the latter is of a contrary nature, and is fatal to animal life, and is also incapable of supporting combustion; it is hence often designated deadly air. Yet in the proper mixture of these two gases, the purity of our atmosphere depends.

In the process of respiration the air is deprived of a large portion of its oxygen, and obtains in its stead a portion of carbonic acid gas, which also, like nitrogen, is not capable of supporting life. It therefore follows that air, after having served the purposes of respiration, or combustion either, is no longer fit for man till it has been purified in Nature's vast laboratory, where that portion which was unfit for animal life is absorbed by the vegetable world and the other substances with which it is brought into contact, and from them it again absorbs its proper proportion of oxygen gas.

Dr. Priestley has given a beautiful exemplification of the powers of vegetables to restore the purity of air which had been deprived of its oxygen. He says, "Finding that air was not spoiled by the growth of a plant of mint which I kept in it for some months, I thought it possible that the process of vegetation might restore the air injured by burning candles, and, accordingly, I put a sprig of mint into air in which a wax candle had burned out, and in a few days after I found that another candle burned perfectly well in the same air which had extinguished it before." He then repeated the experiment with various other plants in a vegetating state, with the same result; and also in

air which had been deteriorated by animal respiration and putrefaction, and thus deprived of its oxygen. From these proofs of restoration of the air, he justly inferred what is now amply proved, that the injury continually done to the atmosphere by the respiration of such a multitude of animals, and the putrefaction of such masses of matter upon the earth's surface, is repaired by the vegetable creation. And notwithstanding the prodigious mass of air that is corrupted perennially by the causes named, yet if we consider the immense profusion of vegetables upon the face of the earth, inhaling and exhaling continually in accordance with their laws of vitality, we may perceive it to be a rational supposition that the remedy is fully adequate to the evil. Thus, by the wisdom of the Creator, the two great departments of the organic world, animal and vegetable, are mutually made to sustain each other; that which is rejected as superfluous by the one being reciprocally nutritious and even necessary to the other.

Again, the air, as it passes through the lungs, is brought into very close contact with the blood as it returns from its circuit round the system; it is then in a dark, discoloured state, and unfit to be again circulated; in the lungs, however, it is brought into very close connexion with the atmospheric air, from which it speedily obtains a large supply of oxygen, which turns it to a beautiful bright red, and it is again fit to be expelled by the action of the heart to the extremities; the blood by this means has become pure; but the breath, at the same time, has also become vitiated, being deprived of its vital quality, and having imbibed other impurities, chiefly carbonic acid gas, in its stead; it is therefore expired, and fresh air inhaled in its place.

It is, therefore, obvious, that the more we are exposed to the free air of heaven the better will be the state of our blood; whereas, deprived of our full supply of this invigorating fluid, the animal frame becomes pale and emaciated; and we have only to compare the healthy ploughman, and the ruddy and hearty foxhunter, with the pale and sickly inhabitant of an over-populated manufacturing district, or the votary of fashion —the victim of the close and unwholesome air of a city fashionable life, to witness the benefit arising from a free circulation of pure air. Of this pure air, an adult requires about a gallon per minute. Now, the space within the curtains of a bed is not capable of containing more than sufficient for two persons for twelve hours; so that if the curtains were quite air-tight, we should cease to exist; and, as it is, such an atmosphere must be prejudicial to health. Nothing can be more ridiculous than the absurd plan of elevating the bed to a great height from the floor, and at the same time bringing the valance down to a considerable depth from the top, thus shutting in a quantity of vitiated air just above. It is said that a bird hung up in a cage within the curtains of a bed where a person is sleeping will be found dead in the morning.]

505. *A little apparatus for ventilating a bedchamber in the night*, invented by the Marquis de Chabannes, though not very effectual for a large room, is perhaps worth mentioning for a small one. It consists of a little box or enclosure of tin or other metal, having an opening in front, *fig.* 80, in which may be placed a small lamp. The upper part or flue is to be inserted into the wall on the chimney breast, and is to go quite into the flue of the chimney. The air which the lamp requires for combustion will thus pass into the flue, occasioning fresh air to come into the room to supply its place. This machine is, in fact, a little chimney, in which the lamp is the fire. It should be placed near the top of the room.

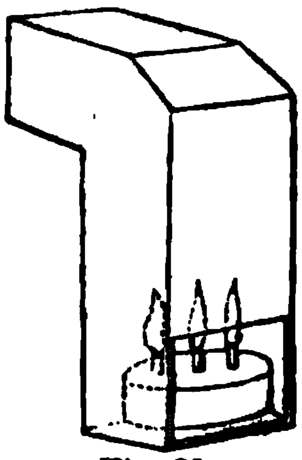


Fig. 80.

506. *It is highly deserving of attention, that although we never use fires without flues, yet we very absurdly have long continued to burn lamps of considerable size, which are, in fact, so many fires, in the middle of our apartments*, even when small, without the least attempt to carry off the burned air which they are constantly generating. No wonder, then, that the air, in such places, is often felt to be oppressive; it is, indeed, extremely unwholesome. It is in vain that we get rid of the smoke by the use of Argand burners; for this, though an evil, is not the greatest one, so far as health is concerned: the poisonous gases given out are much worse. It is to be observed, however, that it is the size and number of the lamps, compared with the size and ventilating condition of the apartment, that creates the mischief; and we wish to draw attention to the fact, that every additional light destroys, or, rather, renders injurious, a certain portion of the air in the apartment where it is burned. We have the satisfaction of stating, however, that the bad effect which suspended gas lights have upon the air of a room may be completely obviated by adopting the invention by Professor Faraday, described in the chapter "on Lamps;" but this will not apply to lights placed upon a table, nor to candles, nor oil lamps.

Our apartments, where large parties are received, are in general lofty, which renders the vitiation of the air less perceived; but when they are lighted up in the evening by numerous lamps or candles, the vital part of the air becomes quickly exhausted, and the visiters, particularly those in delicate health, suffer considerably by remaining long in them, except some means for ventilation be employed. It is difficult to effect this after the houses are finished in the ordinary way; but if the subject be attended to

while they are constructing, methods may be resorted to for producing a change of the air.

507. *The centre of the ceiling of an apartment, fig.* 81, *would appear to be the fittest place for the exit of the vitiated air*, which might then be carried off by means of large tin or other tubes laid horizontally between the joists, and thence to the open air at the top of the house by a flue built in the wall. The aperture in the ceiling may be easily concealed by a large ornamental flower, in plaster or papier machée, which is usually placed there, and from which a lamp or chandlier is suspended. This aperture may be regulated, by having some contrivance by which more or less air may be permitted to escape, as occasion may require; and this regulation may be effected by cords and pulleys worked by a winch or key in the apartment. It may be observed that a coved ceiling is the most favourable for the escape of the bad air. To replace the air that thus escapes, there may lie tubes along or under the floor, by which fresh air may be brought from outside the house, and the admission of which, through gratings or valves placed in convenient parts of the room, should also be regulated.

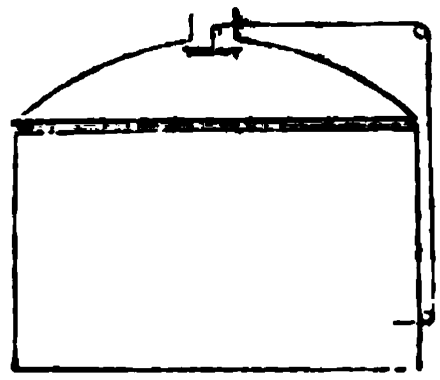


Fig. 81.

508. *In admitting fresh air into apartments* care must be taken that it does not come as a direct stream or current, which will extend to a great distance, and produce draughts not only very unpleasant, but perhaps very dangerous effects: the air may easily be dispersed at its entrance by plates placed before the apertures to divert its direction, or by numerous small apertures. The manner of effecting ventilation of this kind must depend so much upon the particular locality, and other circumstances, that it is impossible to give any positive rules for it adapted to all places.

509. *We have frequently advocated the necessity of studying the principles of science with a view to their application*; and in no subject is this more essential than in the art of ventilation; for a practice that may be the best for one case may be absolutely worthless in another. The air, an invisible fluid, is to be put into motion, which depends upon certain alterations in its specific gravity, to effect which demands some acquaintance with natural philosophy and chemistry. How, then, are persons totally unacquainted with the elements of those sciences to accomplish the task of ventilation under its various complicated cases? All that can at present, perhaps, be safely recommended here, is to confine the methods employed as much as possible to those which are the simplest, as the least likely to be misunderstood.

But if any difficulty can be supposed to exist with chimney fireplaces, which, in spite of all that is said against them, must be admitted to be powerful, simple, and cheap ventilators, giving no trouble, but acting silently, though surely, what, we observe, shall we say of close stoves of every kind, which do not ventilate of themselves, or so inefficiently that it amounts almost to the same thing.

510. *With close stoves the difficulties of ventilation increase considerably*, while the necessity for it remains undiminished. If the fire door is not in the apartment, the stove absolutely occasions no change of air; if in that case the doors and windows of the rooms are kept shut, the air has no chance of being renewed except what little may take place through imperfect workmanship of the house. If the fire is supplied with air from the apartment, still the quantity so supplied, and, of course, replaced from without, is so small, from the economy of fuel and slowness of combustion, that it amounts to a change far short of what is usually wanted for ventilation. On this ground alone, all physiologists must allow that close stoves cannot be healthy, except means can be devised for changing the air independently of their own action; for, otherwise, with them the same air must inevitably be breathed again and again, if there are many persons in the same room, or if it be inhabited long at a time.

511. *Count Rumford considered the ventilation of an apartment warmed by a close stove as a matter easily accomplished*; and he thus expresses himself: "When, in cold weather, a room is kept warm, the air in it, so far from being confined, is continually changing. Being specifically lighter (in consequence of its being warm) than the air without, it is impossible to open and shut a door without vast quantities of it being forced out of the room by the colder air from without, which rushes in; and if at any time it be required to ventilate the room in so complete a manner that not a particle of the air in it shall remain unchanged, this may be done in less time than one minute, merely by letting down the top of one of the windows, and at the same time opening a door which will admit the external cold and heavier air. And it must not be imagined that the room will be much cooled in consequence of this complete ventilation. So far from it, a person returning into it three or four minutes after it had been ventilated, and the air in it totally changed, will not find its temperature sensibly altered. The walls of the room would still be nearly as warm as before, and the radiant heat from those walls, passing through the transparent air of the room, without any sensible diminution of their calorific powers, would produce the same sensation as they did before. And even the cold air admitted into the room would, in a few minutes, become really warm. And as the

specific gravity of air is so very small compared with that of the dense solid materials of which the walls, floor, and ceiling of the room are constructed, the warming of this air will not sensibly cool the room. Hence we see how easy it is to ventilate warm rooms in cold weather, and also how impossible it would be to live in such a room without the air in it being perpetually changed, and replaced by fresh and pure air from without." These principles and directions by the count are good, and generally practicable, provided the occupier of the apartment will put them in practice himself at proper times. Although we are of opinion that considerably more than "one minute" will be necessary for the operation, yet there is no doubt that in this manner a warm room may be easily ventilated. Still it must be recollected that it may not be always convenient to set a door and window open, particularly in winter, in rainy or snowy weather, when such a stove is most wanted; and since much care and judgment will be required in choosing the proper time, and determining how long these apertures shall remain open, this operation could scarcely be intrusted to ordinary servants. It is, however, useful to know that such ventilation is not absolutely impossible, nor extremely difficult, provided sufficient means are employed for the regular performance of the above process.

Some have recommended keeping a small part of the top sash always open, when a close stove is used. It is obvious that another aperture must be provided for the admission of fresh air, otherwise the stove will supply itself from the window, and counteract the intended ventilation, except, indeed, the crevices are sufficient, and these are apt to produce unpleasant draughts.

512. *The cases we have hitherto considered of ventilating, by means of sashes*, suppose that the air in an apartment is considerably warmer than that out of doors; but when the temperature within doors and out are the same, which is often the case in summer, spring, and autumn, little or no change can be effected by opening windows, except, indeed, in a small degree, if the wind should happen to blow that way; and it may happen that a number of persons may be crowded together in a room in warm weather. For such cases, which are not, it is true, of common occurrence, no provision has hitherto been made or brought into common operation in domestic buildings.

513. *Forced ventilation* has been practised in some buildings, and often with great success. Various means have been used to *force* a portion of the impure air out of an apartment; and, from what we have stated, it will be easy to see that, to introduce fresh air to replace it, certain openings only are required, as the air will come in of itself; but care should be taken that this fresh air shall be pure, which it can scarcely ever be from a basement story.

514. *One of these methods of forced ventilation* is by having a lofty tube to proceed from the ceiling by which the hot air escapes, and in which a current of air sometimes is still farther excited by heat applied to it. This heat may consist in a fire, or lamps, or steam tubes. The hot air being drawn off by this contrivance, cool air, or air slightly warmed, is admitted at convenient places in the lower part of the building.

515. *Another mode is the employment of a machine* that draws out a portion of the air in the manner of a large pump with valves, or like a revolving fan enclosed in a box. Some of these mechanical modes have been very successfully applied to ventilate ships, prisons, manufactories, or places of that kind.

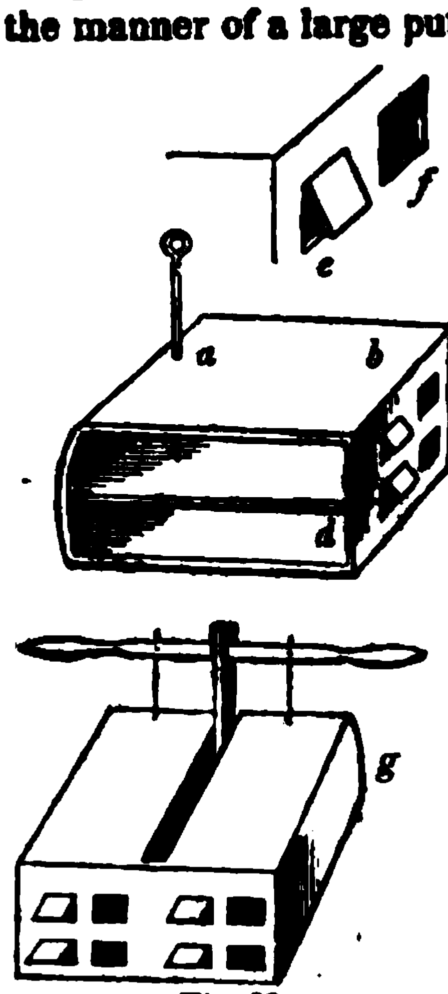


Fig. 82.

516. *The following description of Dr. Hales's ventilator* is given in this place as being exceedingly efficacious, and at the same time so simple, that it might be easily executed by any carpenter; it may suggest ideas to those who wish to contrive mechanical methods of ventilation. It is described in the "Trans. of the Roy. Soc., 1741." *a b*, *fig.* 82, is a square box, in which there is a partition, *c d*, moveable up and down upon hinges of leather at the end, *d*, the other end, *c*, coming close up to the curved side of the box, so as to move easily, but without permitting much air to pass. The motion of the partition is effected by means of the upright rod and handle fixed at *a*. On the side of the box are four valves of wood, two opening inward, and two outward: these valves are represented on a larger scale at *e* and *f*, above.

When the partition *c d* is made to rise, the air in the upper division is forced out through the valve that opens outward, while, at the same time, in consequence of the partial vacuum formed in the lower division, air enters into it by the lower valve that opens inward. When the partition is depressed, the contrary action of the valves takes place; that which before permitted air to enter now suffers it to go out. There are, therefore, two valves constantly permitting air to enter while two others are permitting it to escape. If such a machine is worked into any place where the air is foul

and is to be expelled, at each movement of the partition *c, d*, a quantity of the bad air is taken into the box through two of the valves, and thrown out by two others, to which tubes (not represented in the woodcut) may be connected to convey it away. *g, fig.* 82, shows how two of these machines may be joined together, so as to produce double the effect. Considering the simplicity of this contrivance, and the ease with which ships and buildings might be ventilated by its means, it is surprising that it has not been brought into general use: this can only be accounted for by recollecting that the great importance of ventilation was not generally understood when Dr. Hales first drew attention to the subject of foul air; and that it has been only within a few years that the eyes of the public are beginning to be opened to the great value of ventilation to health.

517. *In Hindostan a sort of ventilation is produced* by the use of the *Punka*, which is a large fan suspended from the ceiling; to this a rope is attached and passed through an aperture in the wall into the verandah, where a man is placed who keeps constantly waving it by pulling the rope. By this the largest rooms, and some churches, have the air put into constant motion, to the great comfort of all present.

518. *In cotton factories the foul air is extracted by machinery.* Fans are made to revolve with great swiftness, at the rate of 100 feet per second; and by their means a constant renewal is ensured of the atmosphere in any range of apartments, however large and closely put up they may be. When such a fan is in full action, and placed at the end of an apartment 200 feet long, it creates a draught at the other end of the apartment capable of keeping a weighted door 6 inches ajar. As this method is found to be very effectual, and as it is applicable in many other situations as well as manufactories, we shall quote the description of it as we find it in Dr. Ures's "Philosophy of Manufactures."

519. *Fig.* 83 *represents a side and front view of the simple and economical fan, which has been of late years employed for ventilating factories*, by drawing the air out of every apartment; for removing through tunnels the dust disengaged in cleaning their fibrous materials; for blowing the air into their extensive ranges of forge fires, and many other similar purposes. It consists of two cast iron end plates, A, A, having a central circular opening, *c, c, c*, from the circumference of which the outline of each plate enlarges spirally, the point nearest the centre being near *d*, and that farther off being under E. This pair of parallel plates is connected by bolts, *a, a, a*, a mantle of sheet iron being previously inserted into grooves cast in the edges of the end plates, so as to enclose a cavity with an elongated outlet at B, to which a pipe is attached for carrying off the wafted air in any direction. Within this cavity, a shaft, C, revolves in bearing, *b, b*, placed centrally in the frame plates, A, A, and cast in the same piece. On this shaft a boss is wedged fast, bearing five flat arms, *c, c, c*, to which are riveted five plates or wings of the shape shown between *a* and *a*, in *fig.* 83, having a semicircular piece cut out of them on each side about the size of the end opening. On one end of the shaft, C, beyond the box bearing, the loose and fast pulleys, D, are fitted for receiving the driving band, and for turning the wings in the direction shown by the arrow. Thus the air is driven before them out of the end of the orifice, B, while it enters by the side openings at *c, c, c*. By the centrifugal force of the revolving wings, the air is conducted towards their extremities, and makes its escape from the pressure through the orifice B, while it is continually drawn in at the sides by its tendency to restore the equilibrium. The fans constructed by some engineers have their mantles made concentric with their central shafts, and though they do good work when turned with sufficient rapidity, they are not adapted to produce pressure by condensation, as the wind issuing from the outlet, B, consists partly of the air compressed by the extremities of the wings, and of the air rarified on its entrance near their roots. In the fan here represented, called the eccentric, the air which escapes through the outlet, B, has undergone compression during its whole progress through the spiral space with the revolving wings, and is equal in density to that compressed at their extremities by the centrifugal force. This fan discharges, therefore, considerably more air than that with a chamber concentric with its wings, because each wing, in passing the point *d*, acts as a valve to cut off the entrance of the uncondensed air, which would cause an eddy, and retard the proper current by the inertia of its particles. The fan produces its greatest effect when the extreme points of its wings percur in revolving about eighty feet per second. When the fan is employed to draw air out of a series of independent chambers, it has its circular side openings, *c, c, c*, enclosed within cases, which are connected with pipes communicating with these chambers. Slide or throstle valves may be placed in the exhausting, as well as in the condensing pipes, for regulating the distribution of the rarefying or blowing power.

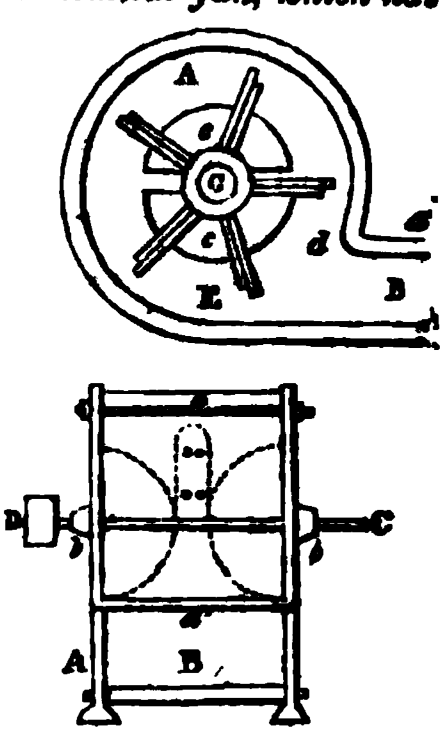


Fig. 83.

By this machine it appears that a renewal of the air is always ensured, which can seldom be the case except some such mechanical method be employed.

520. *Dr. Ure mentions another instance of successful ventilation*, employed in a range of dwelling rooms for the people employed in a cotton factory. A large iron pipe is led along the ceiling of an external corridor, shut at one end, but connected at the other with the great chimney of the mill. From the side of this horizontal pipe, opposite to each apartment, a tin tube, 1½ inch in diameter, branches off at a right angle, and enters through the wall, so as to present its open end immediately over the bedstead of the apartment. Whenever the steam-engine is stopped, either at meal hours or at night, the mechanism which shuts the fire damper is so constructed as to open; at the same instant, the valve at the inner end of the corridor pipe; whereupon a brisk current is established in each tin tube, and a stream of air rushes into it from every apartment, thus forcibly abstracting the air of the room, which, of course, will be immediately supplied by fresh air from without by means of the door and the various crevices. Since this plan has been adopted, the health of the inhabitants has been materially benefited.

521. *One of the advantages of ventilation by means of machinery, is the certainty that a change of the air is effected*; whereas, in many of the other modes, as air is an invisible fluid, it is not always easy to ascertain whether a current of foul air is going out, while another of fresh air is setting in. But however easy these modes of forced ventilation may be in manufactories, where power is at hand to work machines, and skilful people to direct them, they would obviously be too inconvenient to be applied generally in domestic economy, where the simplest means only can be expected to be generally resorted to. Nevertheless, there may be cases and occasions where the knowledge of what is done in other places may be useful. In the ventilation of the houses of Parliament, which has proved so successful, mechanical means on a great scale have been employed.

CHAPTER III.

FUMIGATION, OR DISINFECTING BUILDINGS OR APARTMENTS.

522. *Connected with the subject of ventilation, or renewing the air, in ordinary cases, is that of fumigation, or disinfecting the air*, when it is contaminated by pestilential or other highly noxious effluviæ, which are capable of exciting immediate disease. The general deleterious nature of several gases, as carbonic acid, sulphuretted hydrogen, carburetted hydrogen, phosphuretted hydrogen, &c., has been already mentioned; but there are many vaporous bodies, the existence of which we know or surmise only from our experience of their effects, but of the actual nature and chemical composition of which we are totally ignorant; and these go under the general name of *miasma*, or noxious effluviæ. From the facts which are known, there can be no doubt that, in limited spaces, as in crowded ships, jails, and hospitals, and particularly where cleanliness is neglected, or in confined apartments, where typhus and other infectious fevers exist, the atmosphere is loaded with certain exhalations, fumes, or vapours, which are the cause of contagion, and repeated endeavours have been made to neutralize these by some chemical means.

523. These endeavours have been productive of useful results; and it is now known that *several substances have the property of destroying the noxious quality of at least some effluviæ*, particularly those of certain fevers, and the poison arising from pestilence.

524. *Muriatic acid* was tried with success by Morveau, in 1773, in disinfecting the air; and though more powerful means are now known, it will be useful to describe this, among other methods, since circumstances may sometimes prevent the most efficient from being resorted to. To employ muriatic acid, put some common salt into an earthenware dish, and pour upon it some sulphuric acid: immediately whitish fumes will arise, which consist of the muriatic acid gas; they will blend with the air, and become invisible, but their presence will be perceived from their suffocating smell. All metallic substances capable of being corroded by the acid vapours should be removed; the room or building to be disinfected should be shut up for some hours, and a current of air passed through it before it is again inhabited. In this way Morveau disinfected the cathedral of Dijon, which had been rendered dangerous from the putrid emanations from the burial vaults beneath. He likewise purified, in the same manner, the air of the prison infected through a malignant fever. Twelve parts of acid to fifteen parts of salt is a good proportion. No heat is required.

525. *Nitric acid fumes* have been employed for the same purpose. These were first proposed by Dr. Johnston of Kidderminster, and successfully employed by Dr. Carmichael Smythe, in 1780, to whom the Parliament voted £10,000 for disinfecting the depôt of Spanish prisoners at Winchester, where a fever had proved very fatal. To prepare this gas, put equal parts of pounded nitre or saltpetre and sulphuric acid in a dish, as in the last case. The nitric acid fumes, which are red, are not so effectual as the muriatic, but they have a less suffocating odour, and may therefore be employed in places from

which the sick cannot be removed. For a chamber containing 700 cubic feet of air, four drachms of nitre and two drachms of sulphuric acid are sufficient. They may be put into a teacup, and stirred with a tobacco pipe. But as nitric acid can be purchased at every chemist's shop, a simpler mode of using it, when it can be procured, is to place a two ounce vial full of the *fuming nitrous acid*, with the stopper out, on the mantel-shelf in the rooms which it is wished to guard from infection. The red fumes which constantly issue from the acid will be sufficient for the purpose; they produce an odour not disagreeable, which may be felt on coming into the room, but not enough to be perceived on remaining some time in it, and they destroy the close and unpleasant smell of a sick chamber.

Some recommend putting sulphuric acid upon a mixture of saltpetre and of common salt: it is evident that thus both muriatic and nitric acid fumes will be formed; but these, in large quantity, will be too suffocating for a chamber in which the patient is to remain, and will require that all articles of steel should be removed before the fumigation. In small quantities they may be employed; but the nitric acid alone appears preferable.

526. *Chlorine is the most effectual gas for the purpose of disinfecting the air in apartments.* It was first suggested by Fourcroy, in 1791, and it is now very generally employed. It has the advantage of destroying some noxious vapours that the above-mentioned gases have little effect upon, as sulphuretted hydrogen; and it is, upon the whole, more to be depended upon than any other similar substance. To produce chlorine for the purpose of fumigation or disinfecting, put ten ounces of common salt, well dried, two ounces of powdered black oxyde of manganese, into an earthen pan, together with six ounces of strong sulphuric acid diluted with four ounces of water. The earthenware vessel should be placed in hot sand. This will be sufficient for a room forty feet by twenty.

The chlorine gas will be formed by this mixture, and will rise from it. It has an extremely suffocating smell, and particular care should be taken not to inhale the gas where it is formed, as it is extremely irritating to the lungs, and will produce all the symptoms of a cold and cough. When attempted to be breathed quite pure, it has proved fatal. The place, therefore, where it is used should be shut up with the gas in it for ten or twelve hours, and should be entered cautiously, taking care to have afterward a free circulation of air through it to carry off the chlorine. This method of using the gas is inconvenient in small apartments, but may be easily managed in large buildings when empty.

The irritating and dangerous effect upon the lungs by the use of the gas extricated in the above manner, is obviated by employing the following combinations:

527. *Chloride of lime and chloride of soda are the substances now used as the most convenient, and the most effectual preparations for the purpose of disinfecting.* It is found that chlorine will combine with pure lime and pure soda, making chloride of lime and chloride of soda, but that the affinity of chlorine for these substances is very weak. As the attraction of lime and of soda for carbonic acid is stronger than for chlorine, upon chloride of lime being exposed to the atmosphere, it becomes decomposed by the lime taking carbonic acid from it, and, consequently, leaving the chlorine free to escape, which it does very slowly; and the change is more rapid when the air is charged with putrid effluvia, because the carbonic acid then present promotes the decomposition. Nothing more is necessary, therefore, than to put some chloride of lime, with forty times as much water, into dishes, and place them in the room which it is required to disinfect or to guard against contagion, or to remove any disagreeable smells.

The odour of the chlorine, which issues spontaneously, is rather unpleasant, and excites coughing at first; but the best way is to begin with a quantity too small for that, and to increase it gradually. This inconvenience is, however, trivial when compared with the pernicious nature of the effluvia from contagious or infectious disorders. In cases where infectious diseases are so near that danger is apprehended, chloride of lime or of soda are the best known preventives; and they are so safe, that they may be used wherever there are sick patients, except in the commencement of fever, when it would be hurtful for them to remain in the room with the gas.

528. *Chloride of lime was formerly called the oxymuriate of lime, and is the well-known bleaching powder.* It is made by exposing thin strata of newly-slacked lime in fine powder to chlorine gas in a closed vessel; the gas is absorbed. The chloride is a dry powder, having a faint smell of chlorine. When dissolved in water, it is the *bleaching liquid*. Being made in large quantities for manufactures, it may be had at many chemists' shops, and every chemist knows how to procure it

A solution of chloride of lime in water may likewise be sprinkled over the apartment to destroy offensive smells. A cloth wetted with it, and laid over a corpse for an hour or two where putridity has commenced, will prevent any effluvia from being perceived; and in this manner it is sometimes employed in cases of dissection. By breathing through a sponge dipped in this fluid, a person was enabled to descend and walk with impunity along a public sewer in Paris, where previous attempts to enter it without this precaution had cost many lives. The same method might be used in emptying drains, cesspools, or other places where putrid matter renders the place dangerous; and it has

been employed with success in destroying the stench of bilge-water in ships, and correcting the confined air of their holds. Clothes worn by persons during pestilential diseases are disinfected by being washed in a solution of chloride of soda; and the linen of sick persons, where there is any danger of infection, should be put into water with chloride of lime or soda as it is taken off. This solution is also found extremely useful as an application to ulcers or putrescent sores.

529. *Chloride of soda, which is equally efficacious with chloride of lime, is known by the name of Labarraque's disinfecting liquid.* It is prepared by passing a current of chlorine gas through a cold and rather dilute solution of common carbonate of soda. It is necessary to send as much chlorine into the solution as will displace the whole of the carbonic acid. A particular account, by Mr. Faraday, of the mode of preparing it, may be seen in the Quarterly Journal, New Series, II., 84. The employment of these powerful disinfecting agents should not, however, prevent the use of all other means which may be considered as additional securities; such as washing clothes and linen, whitewashing, scouring, &c.

530. *Tobacco smoke* is considered by some persons as a preservative from infection; but its influence is, at least, extremely doubtful.

531. *Camphor* has been very generally relied upon as a protection against infectious diseases; but its value is estimated very low at present among physicians.

532. *Vinegar* is certainly useful; and although its disinfecting properties are perhaps very small, yet it is at least very refreshing in a sick-room, both to the invalid and the attendants, in overcoming the unpleasant odour usually prevalent. It is either sprinkled over the floors, or the vapour is produced by pouring vinegar upon a hot iron. For this purpose aromatic vinegar and Thieve's vinegar are thought to be preferable, as they contain a little camphor and aromatic oils.

533. *To destroy the disagreeable effluvia from sewers, privies, and similar places,* quicklime alone, or mixed with lees of ashes, or soapy water that has been used in washing, may be thrown down into the sink of the privy. This is much employed in hot countries in places where putrefying matter is collected, to prevent its dangerous effect upon the atmosphere, which would produce disease. But, as we have already observed, noxious effluvia from all underground places should be prevented by properly-constructed traps.

BOOK IV.

ARTIFICIAL ILLUMINATION.

CHAPTER I.

ON LIGHT AND FLAME.

SECT. I.—HISTORICAL REMARKS.

534. *Artificial light is probably as ancient* as the human race or the use of fire; but the means employed to produce it among savage tribes have scarcely advanced beyond burning branches of trees or splinters of wood. Torches were probably an improvement upon these; and lamps, even of the simplest kind, display a great advance in refinement, requiring a combination of contrivances, such as the preparation of oil, a vessel to hold it, and a proper substance for the wick.

It is not a little remarkable that the ancient nations, who evinced such skill and taste in several of the elegant arts, should have made no improvement in the simplest kind of lamp, except that of its form. Although antique lamps have been found in Herculaneum, Pompeii, and other places, of almost infinite variety, made of baked clay or of bronze, from the most simple forms to those of the most studied description, exhibiting a surprising variety of designs, and admirable for the beauty of their workmanship, yet the principle of the lamp scarcely varies from what must have been the original contrivance—an open vessel, with a wick laid in the oil. The light which these supplied must have been weak and unsteady; and, as there were no means for destroying the smoke, this must have been annoying in closed apartments, when the oil was bad. The lamp was sometimes suspended, and, occasionally, was placed upon that elegant piece of furniture, the candelabrum or stand, of which some of the most beautiful forms in marble and bronze are still preserved.

535. *Simple as is the contrivance of candles, they do not appear to have been generally known to the ancients,* who continued long to make use of the lamp only. We read, however, of a species of candles sometimes used among the Romans, made of strings of papyrus, or rushes, dipped in pitch and surrounded with wax. Wax and tallow candles were, according to Pliny, likewise occasionally employed in religious offices. Torches and flambeaux were used at all times; and in the early part of the modern period we find that, at great entertainments, halls were lighted up, not only with lamps, but with flambeaux held in the hands of domestics kept for the purpose. Froissart, in

describing the magnificence of the Count de Foix, states, that he had twelve torches, held by twelve valets in his hall. These were afterward superseded by the invention of candlesticks. In the twelfth century, candles of wax, and chandeliers, were generally seen in churches; and, as refinement increased, they came gradually into use among the nobility and wealthy all over Europe, as did those of tallow among the middle classes. The discovery of Argand, by which the smoke of lamps was destroyed, produced a new era in artificial illumination; and these implements, which had long been laid aside in the best apartments, were again introduced. Various modifications of this admirable invention have resulted from the endeavour to carry the improvement still farther, and still continue to exercise the talents of philosophers and mechanics. Inflammable air, or gas-lighting, has added immensely to our means of artificial illumination, particularly in streets, shops, and public buildings; but all these modes have peculiar properties, which require to be examined separately.

Sect. II.—Nature and Laws of Light.

536. Although the artificial light produced by combustion is in several respects different from that of the sun, yet the general laws observed by both are the same; and we shall be able to make the nature of the former best understood by first briefly describing the chief properties of solar light, or that of day.

537. *It is not known with certainty what light really is*, but there are two prevailing opinions respecting it. By some it is supposed to consist of streams or rays of excessively minute particles, sent off in all directions from luminous bodies. Others imagine that there are no particles of this kind, but that luminous bodies have the property of causing vibrations or undulations in an ethereal fluid that fills all space, and that thus an effect is produced on the eye analogous to that on the ear in sound, which is known to be the result of invisible undulations or waves formed in the air by sonorous bodies. But, whatever may be the fact (and this cannot at present be absolutely determined), either of these theories explains most of the phenomena of light; and, as the first-mentioned has greater simplicity in its favour, we may adopt it, on the present occasion, as the most convenient for our purpose.

538. *The rays of light from the sun proceed always in perfectly straight lines, parallel to each other*, and never in curves of any kind. This may be seen distinctly by admitting them into a dark chamber through a hole in the window-shutter, *fig.* 84. But the rays which proceed from a candle or lamp diverge, or spread out, as they proceed from the flame, *fig.* 85, though they also move only in straight lines. It is important to distinguish these facts in the consideration of light employed in illuminating.

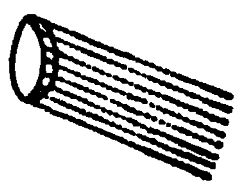


Fig. 84.

539. *When the rays of light, whether of the sun or of any other luminous body, strike upon a solid substance, a considerable portion is reflected*, or thrown off again, precisely in the same manner as when a boy's marble rebounds from a stone slab on which it is thrown: and this reflection obeys a constant law, to understand which is essential to our subject. Suppose the rays, *a b*, *fig.* 86, come to the surface, *c d*, in the direction *a b*, making a certain angle, *a b c*, with that surface, they will be reflected, or will bounce off from the surface in the direction *b c*, making the angle *c b d* exactly equal to the angle *a b c*. The angle *a b c* is called the *angle of incidence*, or striking; and the angle *c b d* is called the *angle of reflection*; and the rule in all cases is, that the angle of incidence is equal to the angle of reflection. This is the foundation of all our reasoning on the operation of *reflectors* of various kinds, which are so often used in the management of light; and a few illustrations will render this familiar to the reader.

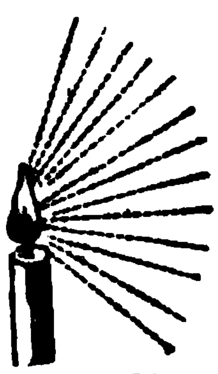


Fig. 85.

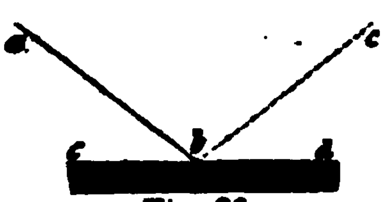


Fig. 86.

c Fig. 87. d

If a piece of looking-glass, *c d*, *fig.* 87, be laid flat upon a table in a darkened room, and a ray of light, A, be admitted through a hole in the shutter so that it may strike on the mirror, it will be seen that the ray will be reflected to B, making the angle of incidence equal to that of reflection; and likewise that the several rays, both of incidence and reflection, do not diverge, but continue parallel. But the beam of light from a candle, C, *fig.* 88, diverges before it strikes the mirror; and, as each single ray makes the angle of incidence equal to that of reflection, it is evident that the rays must continue to diverge when they are reflected, as in the dotted lines. When a candle, E, *fig.* 89, is put before a flat mirror, F G, on the wall of an apartment, the rays diverge, and, on striking the mirror, they are reflected, and continue to diverge, being thus diffused through the room. Although light is reflected by all bodies

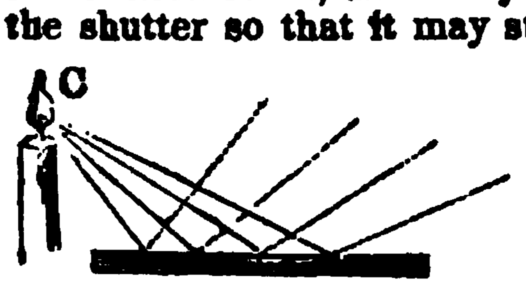


Fig. 88.

Fig. 89.

on which it strikes, yet, if the surfaces are rough, a great portion is absorbed and lost, and only a small part is reflected; but if the surfaces are polished, much more is reflected; and this quantity is in proportion to the degree of smoothness; for this reason, all reflectors should be kept highly polished, which will be known by their appearing bright.

540. *Curved surfaces reflect light* according to the same law, viz., that the angles of incidence and of reflection in each ray are exactly the same. To illustrate this, suppose a concave mirror, *fig.* 90, of which the centre of concavity is at *a*; or, in other words, that *a* is the centre of the circle, of which curve of the mirror B C is a portion: if a number of parallel rays, *d e*, such as those of the sun, strike upon the mirror B C, each separate ray will be reflected so that its angle of reflection will be equal to its angle of incidence; but, from the nature of the curved surface, the result will be, that all the reflected rays will meet together in one point; and this point will be exactly half way between the centre, *a*, and the surface of the mirror: such a mirror, if of sufficient size, would collect the sun's rays so as to burn at the point *f*. Now suppose that an artificial light, as a lamp or candle, was placed in the point *f*, the rays will diverge towards the mirror, and they will be reflected so as to be parallel in the direction *d e*. It is upon this principle that a light may be sent to a vast distance; and thus the light from the candles in coach lamps are confined to the space along the road. If the light should be placed between *a* and *f*, as at *k*, *fig.* 91, then the rays will be collected in a point farther off than *a*, as at *g*; and if it is placed nearer to the mirror than *f*, as at *m*, the reflected rays will diverge, as *h*, *i*.

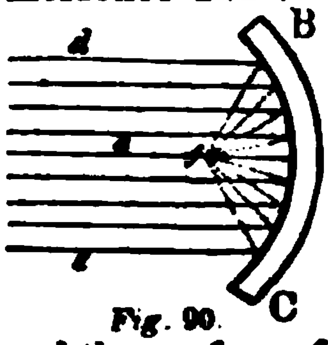


Fig. 90.

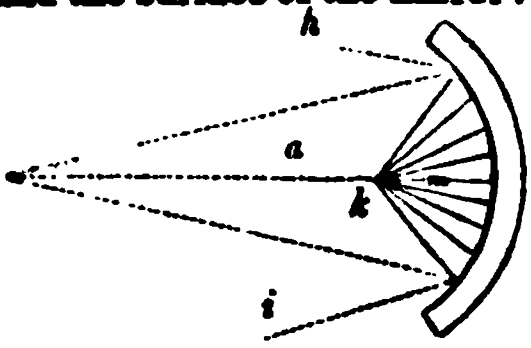


Fig. 91.

541. *Reflectors are sometimes made by* placing a number of small flat pieces of mirror so that the middle of each just touches the curve of a circle, as in *fig.* 92. This arrangement of mirrors, though less perfect than a single curved mirror, acts nearly in the same manner, each small piece throwing its rays to the centre of the circle. Here the greater the number of pieces the better, so that they are set accurately. This kind of reflection is often used where the size is very large, or where economy is much an object, no grinding to a curved surface being necessary.

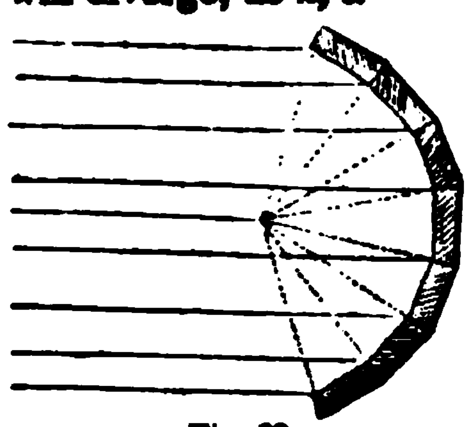


Fig. 92.

542. *Light may be also collected and concentrated by means of glass lenses.* This depends upon a very different principle from the *reflection* of light. It is caused by what is termed the *refraction* of light, which is the change in their direction which rays undergo when they pass out of one transparent substance into another of a different density; but for the laws of refraction we must refer the reader to some work on optics, as our limited space will not admit of its explanation in this work. We shall content ourselves with giving some of the most useful practical results.

543. *A lens* is a piece of glass ground with one or both surfaces spherical. A complete sphere of glass, or a hollow globe filled with water, is sometimes employed to collect the rays of light into a point or focus. If a candle or lamp, *a*, be placed near to such a globe, *b c*, *fig.* 93, the rays, after diverging, will, by passing through the globe, be made to converge to a point *d* on the other side of the globe; and since all the light that falls upon this globe will be collected into a very small spot, this will, of course, be strongly illuminated. This contrivance is often used by jewellers and others for procuring an intense light to be thrown upon their work.

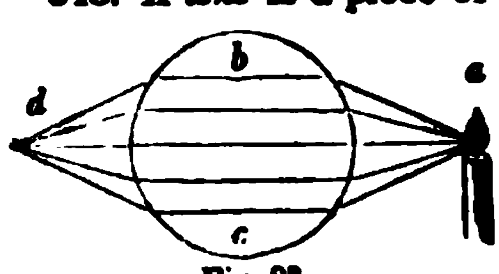


Fig. 93.

544. *A plain convex* lens is a circular glass, flat on one side, and ground spherically on the other, as in *fig.* 94. This collects the rays into a focus, which is more distant than in the case of the globe; and the curved side may be either the half or a segment of a sphere. It is used in some lamps, and the focus may be farther off or nearer, according to the place of the light.

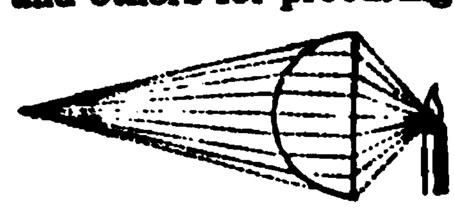


Fig. 94.

545. *A double convex lens*, *fig.* 95, is likewise employed for a similar purpose, and is frequently used in such instruments as the magic lantern, lucernal, and other microscopes, telescopes, &c.

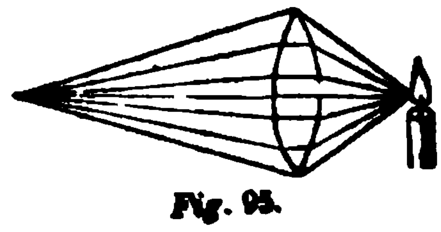


Fig. 95.

546. *We must refer the reader also to works on optics for a description of those beautiful experiments*, by which it has been shown that a beam of the sun's light, though colourless, consists of seven different coloured rays, which can be separated from each other, forming what are called the

prismatic colours; and it is this separation that gives rise to the vivid colours we see given out by the diamond and by cut glass.

547. *It has likewise been shown that the rays of the sun, which produce light and colour, are distinct from those which produce heat*, although they always accompany each other; and here we may point out a remarkable difference between the rays that proceed from the sun and those which come from a fire. In both there are rays of heat and rays of light, that is, heat-making rays and light-making rays; but both these kinds of rays proceeding from the sun pass readily through a pane of glass, as is evident, because in a greenhouse we feel the heat as well as see the light of the sun. But with respect to a fire, the *light* only, and *not the heat*, or very little of it, passes readily through glass; the greatest part of the rays of heat are stopped by it; and, in consequence, a pane of glass fitted into a frame is sometimes actually employed as a fire-screen. *Acquaintance with the above principles* we consider necessary, because they are frequently applied in the various modes of lighting apartments.

SECT. III.—ON THE NATURE OF FLAME, AS EMPLOYED FOR ARTIFICIAL LIGHT.

548. In treating of heat and combustion in Book II., we described the chemical nature of flame; but it will be here necessary to consider it again, with some additional observations relative to its application in affording light.

549. *The nature of flame* has been matter of wonder in all ages, until modern chemistry explained this once mysterious subject. Flame is now considered to be matter that has been volatilized or converted into vapour, and rendered luminous by intense heat. Oxygen is necessary for the combustion which is the cause of the heat, and therefore it is required to support flame.

550. *All bodies do not become luminous when heated:* as, for instance, some of the metals; but iron becomes incandescent, or red and even white hot, when heated to a certain temperature, and various substances require different degrees of heat to render them incandescent.

551. *Common air cannot be rendered luminous by any degree of heat*, and is therefore incapable of producing flame of itself; neither can oxygen gas.

552. *Several of the permanent and natural gases, and also the vapours or gaseous states of several bodies, are capable of being rendered incandescent or luminous* when they undergo combustion in contact with oxygen. Pure hydrogen gas, produced from sulphuric acid and zinc, or iron, is extremely inflammable, and burns with a *weak blue flame* when set on fire by another flame, or even by the electric spark; but though the heat of its flame is considerable, its light is feeble. We explained, when treating of heat and combustion, that the latter effect consisted in the union of the combustible body with oxygen. When hydrogen burns, it unites with the oxygen of the atmosphere, and the result of this union is the formation of water, which is known to consist of hydrogen and oxygen, and which is converted into vapour, and dissolved in the air as soon as it is formed; the flame being the incandescent state of the gas in the act of combining. Carbonated hydrogen, or hydrogen with carbon, which is disengaged from coal or wood by heat, also burns in contact with oxygen; but its combustion affords a whiter and brighter flame than pure hydrogen, that is to say, when rendered incandescent, it throws out more light; and hence it is preferred for the purposes of artificial illumination. Carbonated hydrogen affords more light in proportion to the quantity of carbon it contains; and the carbon is a principal source of the light given by its flame. The vapours of some substances are not combustible, and cannot be rendered luminous; in other words, they produce no flame: as, for instance, steam, the vapour or gaseous state of water. On the contrary, the vapours of other substances are highly inflammable, and, as we have said above, burn with a bright light or flame: for instance, wax; but it is necessary that these vapours should be heated to a great degree before they will burn or produce flame by combining with oxygen. This may be illustrated in the following manner: Put a bit of wax into a fire-shovel heated a little: it will melt; but wax merely melted will not flame, as may be seen by trying to light it by a piece of lighted paper. To make wax produce flame, it must be heated so as to cause it to boil, and then its vapour is highly inflammable. To prove this, heat the shovel red hot; now put some wax on it, and a white smoke will rise, which is the vapour from the boiling wax. Hold a lighted paper in this smoke, and it will immediately catch fire and flame like a candle, and this flame will continue till the whole of the wax is consumed. What is shown here of wax is true also of all the other substances commonly used for producing light, as spermaceti, tallow, oil, resin, &c. They will not afford flame until they are first reduced to the state of vapour.

553. *The flame of a common lamp, or of a candle, is produced in the following manner:* Oil and tallow, we have stated, do not take fire unless previously volatilized by heat; and this is effected by means of the wick of the candle or lamp. The oil or melted tallow rises between the fibres of the wick, in consequence of what is called *capillary attraction*, in the same manner as water would rise up in a piece of the wick suspended in it. The flame of another body being applied to the extremity of the wick, so as to set it

on fire, the oil is heated to the state of vapour, which then inflames; the oil first raised is dissipated by combustion, and another portion is attracted upward by the fibres of the wick, and becoming vapour, is burned likewise, and in this way a constant combustion is maintained. A candle, however, differs from a lamp in a very essential circumstance. The oil of the lamp is always fluid, and only requires to be boiled into vapour by the heat of the wick; but the tallow, being at first solid, has first to be liquefied and brought into the state of oil. What is in the vicinity of the wick is first melted, and the external rim of the candle not being rendered fluid, a cup is thus formed, which contains the melted portion. This circumstance will be adverted to again more particularly when we treat of the management of candles. The melted tallow or oil being boiled by the flame into the state of vapour, ascends in the form of a column, and, being heated to a high temperature, it combines rapidly with the oxygen of the surrounding atmosphere, the heat evolved being so great as to cause the vapour to be white hot and very luminous, thus constituting visible flame. But the combustion that occasions this can only take place in that part of the column of hot vapour which is in contact with the atmosphere, namely, the exterior surface. The flame of a candle or lamp, then, *fig.* 96, is not solid throughout, but only a thin film of white hot vapour, enclosing a quantity of heated vapour, which, for want of oxygen, is incapable of attaining the greatest degree of heat in burning; that is, only the vapour which rises from the outside of the wick, and which is in contact with the atmosphere, can burn by uniting with oxygen; but what rises from the centre of the wick, not being in contact with the air, cannot burn, and rises, of course, unburned. The flame of a lamp or candle is, therefore, in fact, hollow; the dark in the figure representing the hollow part, the upper part tapering to a point.

Fig. 96.

554. *That the flame is really hollow can be proved* by several experiments. By looking attentively at the flame of a candle just snuffed, it will be seen that immediately above the wick there is a part darker or less luminous than the rest, as in *fig.* 96; this is the hollow part, full of unburned vapour. If a piece of paper, held horizontally, be quickly introduced across this part of the flame, and held for a few seconds, the paper will be found to be scorched only in a ring, *fig.* 97, where the circular film of flame was below it, and the centre part will not be scorched. The scorching will be best seen upon the upper side of the paper, as the lowest side will be too much blackened by the smoke.

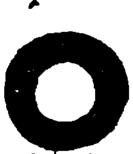


Fig. 97.

By a pretty experiment, it is possible to extract the unburned vapour from the centre of the flame, and to inflame it. Procure a piece of a small glass tube, having a bore of an eighth of an inch; insert the end of it dexterously into the dark part of the flame where the hollow is supposed to be, holding the tube as at A, *fig.* 98, and the unburned vapour will ascend through the tube, and may be set fire to at the top by a piece of lighted paper, forming a smaller flame of the same kind as the first.

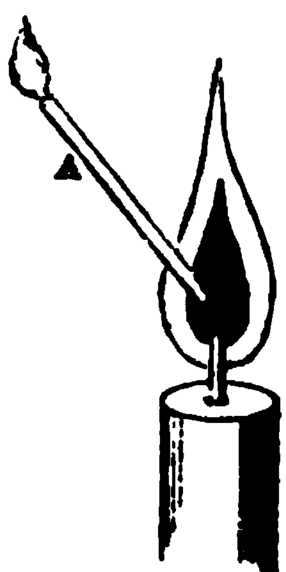


Fig. 98.

555. *It is necessary now to refer the reader to what we have said in Book II., on the chemical nature of combustion. We there stated that* the usual substances employed for giving heat and light were of vegetable or animal origin, as wood, coal, wax, tallow, spirit, &c., the chemical constituents of which are oxygen, hydrogen, and carbon, in variable proportions; and that, in the process of combustion, a complete decomposition of these, or a separation from each other, was effected. This takes place in all the oil burned in lamps, and the wax, tallow, &c., in candles.

556. *We must trace the progress of this decomposition, in order to explain the phenomena which occur in artificial illumination.* When any of the substances employed for giving light is heated so as to inflame, a portion of the carbon and hydrogen unite, forming carbonated hydrogen, which is detached, and becomes luminous by uniting with oxygen in the manner described above. Another portion of the hydrogen alone combines with oxygen, and forms water, this fluid consisting of these two gases in combination. The water thus formed is dissipated through the atmosphere, being so heated as to be in the state of vapour, on which account it is not obviously visible. The light, therefore, proceeds from the combustion of the carbonated hydrogen. Another portion of the carbon of the combustible body unites with the oxygen of the atmosphere, and forms carbonic acid gas, which is likewise disengaged and spread through the surrounding air. But still another portion of the carbon remains, reduced to a vaporous form, ready to unite with hydrogen, and to burn with oxygen; this remaining portion of carbon, however, being in the centre of the flame, has no hydrogen to unite with, that being all, or nearly all, burned; or if there be a little hydrogen left, still no oxygen can find its way to the centre of the flame to complete its combustion; consequently, this carbon vapour remains by itself, and, rising in a column through the upper part of the flame, a part gets burned at the top, where it meets with oxygen, but a large portion also escapes unconsumed. It is this latter part that escapes, which, when it comes into the cool atmosphere, is condensed, and ap-

pears in the form of smoke, which may be collected as a powder in the form of soot on any surface held over it. This escape of unburned carbon vapour may be very instructively watched in the burning of a tallow candle. Sometimes the flame may be observed quite steady, and tapering to a point; then all the carbon vapour is burned at the top, and there is no smoke. Presently the flame is observed to flicker, to become red at the top, and to give out a great deal of smoke; in that case, the carbon vapour has escaped unburned through the flame.

557. *It is obvious from this that the cause of smoke in candles and lamps is because there is no supply of oxygen to the centre of the flame*, in consequence of which the carbon vapour, which fills the hollow part, cannot be consumed, and therefore escapes into the apartment unburned, by which a loss of heat and light is occasioned, into which it would have been converted could oxygen be got to it. This defect in the combustion of lamps has been remedied by the invention of Argand, to be afterward described, and by which oxygen is admitted to the centre of the flame, to consume the carbon vapour which occasions the smoke.

558. *The flames of different combustibles are not all attended with an equal production of heat and light.* Sulphur burns with a weak flame; phosphorus with a very dense one. Spirit of wine burns with a slight flame in point of light, but a very powerful one in respect to heat. If an Argand's lamp be charged with oil, and another similar lamp be charged with spirit of wine, the flame of the latter will not have a quarter of the light of the other, but will give twice as much heat, and is not accompanied by smoke. The flame of ether is denser, but produces smoke. The flame of oil of turpentine is attended with a very dense smoke. The flame of pure hydrogen is very faint, but gives much heat.

559. *The colours of flames also depends upon the nature of the combustible.* Sulphur burns with a blue flame. Spirit of wine, by itself, also burns with a bluish flame. If a little boracic acid be stirred into the spirit of wine, the flame will be beautifully green. If any of the salts of strontian be mixed, the colour will be a fine red; and it is this latter which is employed in the theatres for producing the red light in the representation of conflagrations. The flame of zinc is a bright white: that of the preparations of copper, greenish-blue.

560. *The combustible vapours and gases are not all inflamed with equal readiness.* Pure hydrogen gas may be inflamed, not only by the contact of another flaming body, but even by a very small electric spark. A spark a little more powerful will fire spirit of wine and ether, especially when the fluids are a little warm. Spirit of turpentine, and some essential oils, may be inflamed even by the action of cold acids. Put a spoonful of oil of turpentine in a cup, and pour over it about half that quantity of strong nitrous acid, previously mixed with a few drops of sulphuric acid: the oil of turpentine will immediately burst into a flame. In making this experiment, it is necessary to put the acid into a small phial, which should be fixed to the end of a long stick, that the operator may be at a distance from the turpentine; because the flame is so sudden, that it will be dangerous to bring the hand near it.

The thick fat oils must be heated to a considerable degree before they are in the state of giving out vapour, so as to be inflamed. If a vessel containing oil be set upon a fire, a smoke or vapour begins in time to rise from it, which by degrees grows denser and denser, and at last begins to shine in some places near the surface of the oil, somewhat like an electric light; yet it does not flame; but if a flaming body like a candle be brought within the vapour, the latter will instantly be inflamed, breaking out with a sort of explosion, and will continue to burn till the whole is consumed. Serious accidents frequently occur in boiling oil, pitch, and similar substances, by approaching too near with a light, or by suffering them to boil over, by which their vapour is set fire to, and the whole of the oil is inflamed.

561. *The above principles explained*, it will now be easy to comprehend many of the circumstances connected with light of various kinds, which would be wholly unintelligible without this previous knowledge. We shall proceed to describe the several contrivances which have been resorted to in employing the combustible substances used for giving light, such as lamps, candles, &c.

562. *At present there are three modes by which artificial light is usually produced:* by *candles*, *lamps*, and *gas*. We shall consider these separately; but first we shall treat of the various substances employed to burn for this purpose.

CHAPTER II

OF THE VARIOUS SUBSTANCES EMPLOYED IN THE PRODUCTION OF ARTIFICIAL LIGHT.

Sect. I.

563. *General Remarks.*—The materials from which artificial light is procured are derived partly from the animal, partly from the vegetable, and some from the mineral king-

dom. Animal fat or oleaginous substances, in our common temperature, are either solid, as wax and spermaceti, or always fluid, as fish oil. Of vegetable oleaginous substances, some are always solid in the usual temperature of Britain, as palm oil: others are always fluid, as olive and rape oils. The mineral substances are naphtha, petroleum, &c.

Sect. II.—WAX.

564. *Wax is both an animal and a vegetable production.* The first kind is a secretion by certain insects, of which the bee is the most remarkable. The second is afforded by plants. Wax was long supposed to be merely collected by bees from the pollen of flowers; but this opinion is now known to be erroneous: the pollen which the bees are seen to collect, and to carry home attached to their thighs, is for the purpose of feeding their young. It is, therefore, called *bee bread.* The wax of the bee is elaborated in its stomach. With his tongue he sucks the saccharine juice in the nectaries of flowers; and this is transformed into wax by certain secreting organs in the animal. The wax then exudes through apertures between the abdominal rings, into what have been termed *wax-pockets*, which were first discovered by Mr. John Hunter, and of which the working bees have eight: these are situated under the wings. From the observations of Huber, it appears that sugar is essential to the formation of wax; and that bees supplied with sugar only, and shut up in the house, manufacture wax in the same manner as those bees which enjoy their freedom; which proves that wax is not merely a vegetable substance.

565. *The cells of wax constructed by the bees* consist of two ranges, disposed back to back, in combs that are placed vertically. They are all hexagonal or six-sided; and the accuracy with which they are constructed, and the wonderful instinct by which the form best adapted for the purpose is given, has excited the admiration of mankind in all ages. But the natural history of the bee, so highly interesting, is to be found in many works of the present day; and it is, therefore, unnecessary to describe it farther in this place. The finest wax is made where the bees have access to dry heaths and hilly countries: in places abounding in vineyards it is decidedly inferior. A young hive will yield, at the end of the season, about one pound of wax, and an old hive twice as much.

566. *There are two kinds of wax found in commerce, yellow or unbleached, and white, or purified and bleached.* The yellow is the wax just as it comes out of the hive, after expressing the honey. The dark yellow colour is owing to an admixture of some honey and the bee bread, for the natural colour of wax is pure white.

567. *To procure the wax from the combs for use.* After separating the honey from them as much as possible, by draining and pressing, the combs are either soaked for some days in clear water, in order to extract all the honey, or they are broken into pieces, and spread on a sheet near the hives, so that the bees may in time suck out all the honey that is left. The whole of the comb is then enclosed in a canvass bag, and put into a kettle with boiling water; by this the wax is melted, and it is squeezed out by pressing the bag with a large wooden spoon. The melted wax rises to the surface of the water, and swims on the top. It is next skimmed off, and put into another vessel with cold water, by which it is hardened. It is then taken off, remelted, and cast in wooden, earthen, or metallic moulds, which are first anointed with honey, oil, or water, to prevent the wax from sticking to them.

Before wax is employed for the ordinary purposes, as the making of candles, for modelling, the uses of the surgeon, perfumer, &c., it is rendered white by bleaching.

568. *Wax is bleached* by exposing it in thin laminæ to the action of the light and air, by which it becomes perfectly white, scentless, somewhat harder, and less greasy to the touch. To effect this, it is first broken into small pieces, and melted in a copper caldron, with water just sufficient to prevent the wax from burning. The caldron has a pipe at the bottom, through which the wax, when melted, is run off into a large tub filled with water, and covered with a thick cloth, to preserve the heat till the impurities are settled. From this tub the clear melted wax flows into a vessel having the bottom full of small holes, through which it runs in streams upon a cylinder kept constantly revolving over water, into which it occasionally dips; by this the wax is cooled, and at the same time drawn out into thin shreds or ribands, by the continual rotation of the cylinder which distributes them through the tub. The wax, thus granulated or flatted, is exposed to the air on linen cloths, stretched on large frames, about a foot or two above the ground; in which situation it remains for several days and nights, exposed to the air and sun, being occasionally watered and turned; by this process the yellow colour nearly disappears. In this half-bleached state, it is heaped up in a solid mass, and remains for a month or six weeks; after which, it is remelted, ribanded, and bleached as before (in some cases several times), till it wholly loses its colour and smell. It is then again melted for the last time, and cast, with a ladle, upon a table covered over with little round cavities, into the form of disks or cakes of about five inches in diameter, in which it is usually sold. The moulds are first wetted with cold water, that the wax may be the more easily got out, and the cakes are laid out in the air for two days and two nights, to render them more transparent and dry. This operation of bleaching wax can be per-

formed only in fine weather, as it depends chiefly on the action of the sun; and on account of this inconvenience, it has been a desideratum to discover some other mode of whitening this substance. Chlorine has been found to bleach it much more rapidly; but does not answer completely, the wax being rendered brittle. Steam has also been employed for this purpose; and, by exposing wax to the atmosphere in frosty weather, the bleaching is very soon effected. It is by exposing honey to the frost that the Jews bleach it to such a degree of whiteness as they bring it to in Poland.

569. *In tropical countries, on account of the heat, tallow candles cannot be used*, and therefore wax is much employed. A very simple method of bleaching this substance is made use of there: a vessel containing it is placed within another full of water kept boiling. When the wax fuses, a process for converting it into thin flakes for bleaching is used, that at first sight might appear hazardous. The hands are first dipped into a tub of cold water placed near, and, while wet, plunged into the melted wax; they are instantly and quickly drawn out covered with wax, the heat of which is scarcely at all felt. This wax is stripped off from the hands, and spread out on cloths in the sun, and watered to whiten.

570. *The principal properties of wax are these:* it is insoluble in water and in cold alcohol, but in boiling alcohol a very small portion is dissolved, the greater part of which is deposited on cooling. John, a celebrated chemist, found wax to consist of two substances, one soluble in boiling alcohol, and which he called *cerin*, the other insoluble, which he has named *myricin*; the proportions of each being 75 of the former and 25 of the latter. The first gives brittleness, the last unctuosity, being partly of the nature of a fixed oil. Cerin, when obtained from wax, will form *margaric acid*, a product of saponified fat; but wax itself will not make a soap with the alkalies, a property which distinguishes it from fats, oils, and resins; neither does it contain *elain* nor *stearin*, principles in the latter substances which we shall describe. Wax unites, by the aid of heat, with the fixed and volatile oils, and with resin: with different quantities of oil it constitutes the *cerates* of the apothecaries.

571. *By chemical analysis*, 100 parts of wax are found to consist of carbon 80·4; oxygen 8·3; hydrogen 11·3.

572. *Wax, it has already been stated, cannot be kindled unless it be previously reduced into vapour*, which requires a heat of 300°; in this it resembles tallow and fat oils. Bleached wax burns with a very pure white light, without any offensive smell, and with much less smoke than tallow; and as it is less fusible than the latter substance, it burns well with a smaller wick. It yields in burning the same products as oil. Bleached wax melts at 155°; unbleached at 142°; while tallow melts at 92°, and spermaceti at 133°. White wax is in some degree translucent, but not so much so as spermaceti.

573. *White wax is sometimes adulterated* with white-lead, to increase its weight: this may be detected by melting the wax in water, when the lead will fall to the bottom of the vessel. Adulteration by mixing tallow or suet with it may be known by its greasiness, by a dull opaque white, and its wanting that transparency which pure white wax possesses; as also by its disagreeable odour when melted, and being saponified by alkalies. Potato starch is another ingredient which is sometimes fraudulently mixed with white wax. This may be detected by digesting the wax in oil of turpentine at a gentle heat, which dissolves the wax, leaving the starch. Spermaceti is also employed for adulteration; this mixture has less transparency than pure wax, and it melts more easily; the surface of the cake having likewise a mottled appearance. Wax is also adulterated with resin, which renders it brittle: pea meal and earths are likewise said to be employed. The presence of resin may be suspected when the fracture appears smooth and shining instead of being granular, and it may be detected by putting small pieces into cold alcohol, which will dissolve the resin, and leave the wax untouched. Earth or pea meal may be discovered by remelting and straining the wax, as they will be left behind. When wax is bought, it is proper to break each cake, for it is not unfrequently the case that some impurities are in the centre, the outside only being good.

574. *Besides our large supply at home, a great deal of wax is imported* from Russia, the Netherlands, Barbary, the west coast of Africa, Cuba, and North America; and much more would be imported but for the heavy duty, which is 1*l*. 18*s*. per cwt.

Vegetable wax will be described among the vegetable substances employed for light.

Sect. III.—SPERMACETI.

575. *Spermaceti is an inflammable substance, which occurs* as a spongy, oily mass, in the head of a species of whale (*Physeter macrocephalus* or *cachalot*). It is contained in a large triangular cavity ten or twelve feet long, and four or five feet deep, placed above the fore part of the scull; and an ordinary-sized whale will yield upward of twelve large barrels, or nearly a ton, of this substance in a crude state. While the animal is living, this substance is fluid; and when the whale is killed, a hole is made in the outer and upper part of the head, and the liquid is baled out in buckets; it solidifies to the consistence of fat on cooling. The sperm oil is separated from this by dripping, and pressure in bags: what passes through is the oil, and the residue is the crude spermaceti, which is packed up and brought to England by the South Sea wha-

lers to be refined. The mode of refining it in manufactories is as follows: The crude substance is put into bags of hair or woollen stuff, and subjected to a press till it becomes hard and brittle, and till no more oil can be obtained from it. It is then broken to pieces, and thrown into a vessel with boiling water, when it melts, and the impurities, which rise to the surface or sink to the bottom, are skimmed off and separated by straining. The spermaceti, after becoming solid on cooling, is again thrown into a boiler with water, to which a weak lye of potash has been added to free it from the remainder of the oil. This process is repeated several times if necessary, after which the spermaceti is poured into coolers, where it concretes into a hard white mass, which, when broken, exhibits the beautiful flaky, crystalline appearance seen in the shops.

576. *Pure spermaceti* has very little taste or smell. It is of an almost silvery white, friable, semi-transparent, and unctuous. It is softer and more brilliant than white wax, and it is distinguished from every other species of concrete oil by its superior transparency, high lustre, and crystalline texture. It melts at 112°, and at a higher temperature it evaporates with little alteration. By the assistance of a wick it burns with a clear white flame, superior to that of tallow, and without any disagreeable odour. By long exposure to the air it acquires a yellow tinge, and becomes rancid; but it may again be purified by being washed in a warm lye of potash. It is extensively employed, with wax and olive oil, in making ointment for medical purposes. It possesses, also, the property of softening the skin, and hence it is used by ladies for pastes, washes, &c.; but its chief use at present is in making candles. Some have sold for spermaceti a preparation of oil taken from the tail of the whale instead of that from the head; but this kind soon turns yellow. A small quantity of spermaceti, indeed, is found in all the whale tribe, and is distributed all over their bodies, as also in their fat. The fat of all fishes contains a small quantity of it.

Sect. IV.—Tallow.

577. *Tallow is a variety of animal fat melted down and clarified.* There are scarcely any animals but a sort of tallow may be obtained from them. Those which yield the most are the bullock and sheep; but tallow may also be prepared from the horse, hog, goat, deer, and bear. It is employed for a variety of purposes, as for making soap and dressing leather, but chiefly for candles; and large quantities are annually imported from Russia. The fat of animals is usually collected between the skin and muscles, in the interstices between the muscles and between the viscera. It is composed of cellular membrane, enclosing an oily matter of various degrees of consistence, according to the part. Thus, suet, lard, marrow, &c., are varieties of this substance, which is very analogous in its chemical properties to the vegetable fixed oils; but the suet, being the firmest kind, is chosen for making tallow.

578. *Tallow-chandlers melt tallow* by chopping the fat, as it is taken from oxen and sheep, and then boiling it for some time in a large copper, to separate the tallow from the cellular membrane; when the former is chiefly extracted by this means, the remainder is subjected to the operation of a strong iron press, and the cake that is left, after the tallow is expressed from it, is called "*greave*:" with this dogs are fed, and, it is said, many of the ducks and pigs that supply the London markets.

579. *The tallow for mould candles* should be made of half bullocks' and half mutton suet, the former giving firmness, consistence, and gloss. When of the best quality, tallow is white, firm, and brittle: it is then nearly without taste, but has always more or less of an oppressive odour. To be pure, there should be no admixture of oil or grease of any kind, and it is to this species of adulteration that the bad quality of candles is chiefly owing. It is very important that too great a proportion of mutton suet should not be used; for this possesses a peculiar principle called *hircine*, which has a disagreeable odour that distinguishes it from the fat of other quadrupeds, and which occasions it sometimes to give a disagreeable smell, particularly in hot weather. Hogs' fat causes candles to gutter, smell, and smoke; and the ordinary dipped candles are very often adulterated with kitchen stuff. Tallow is sometimes melted in a vessel heated by a naked fire, which is very liable to injure it; it is much better to employ a vessel surrounded by steam: a little alum is put in with the tallow to harden it.

580. *Foreign tallow has often a yellow tinge, and frequently contains a considerable portion of sebacic acid:* it is generally inferior to the English; but Mr. Parkes informs us, in his Essays, that the former may be purified at a trifling expense by chemical means; and by the proper application of chemical agents brown tallow may be rendered beautifully white, and fit for the best purposes. If tallow is bad, a part soon becomes converted into acid by exposure to the air; and this renders the whole, when melted together, unfit for the making of candles.

581. *The method recommended for separating the sebacic acid from the tallow* is that of melting it in water containing some alkali. But old tallows may, in general, be sufficiently purified from their rancidity by melting them upon lime-water, and giving a considerable agitation to the whole mixture: when the water is again suffered to sub-

side, it will be found to be offensive in smell, and to have subtracted most of the impurities of the tallow. Should it, however, be found not to be sufficiently purified, a repetition of this process will be found effectual.

582. *The late discovery respecting tallow, by which it is shown to consist of two substances, stearin and elain,* will be described in Chapter III., Book IV., under "Composition Candles."

Sect. V.—Oil.

Subsect. 1.—*General Observations on Oil.*

583. Of all the substances employed for procuring artificial light, oil is the most extensively used. This substance, in its purest state, *when analyzed by the chemist*, is found to consist of carbon, hydrogen, and a small proportion of oxygen; and its distinctive characters are, that it has always unctuosity, is insoluble in water, not uniting with it by itself.

584. *Oils are divided into two great classes:* fat or fixed oils, and volatile or essential oils.

585. *Fixed oils* are so called because they do not boil or become volatilized, and do not inflame until they are heated to 600°. When they are heated nearly to this point they begin to decompose, and give out a vapour which is very inflammable, and which constitutes carbonated hydrogen or oil gas. The oil does not ignite, indeed, until it is brought into a state of vapour; and on this account, as we have before stated, wicks are necessary, by enabling a small quantity to be successively exposed to a high temperature: it then burns or ignites in atmospheric air, a large quantity of light and heat being given out by its combustion. That this should be complete, free access of air is essential; for if the supply of air be imperfect it burns with a black smoke, which arises from a portion of carbon vapour escaping without being burned, as explained already. It is the fixed oils that are usually employed in procuring artificial light.

586. *Volatile or essential oils* are seldom used for this purpose; they are converted into vapour at a low degree of heat, and their great volatility renders them unsuitable for the ordinary purposes of illumination.

587. *Fluid oil is procured* both from animal and vegetable substances. When obtained from animals in the solid state it is called *fat* and *tallow*, which have been already described; fish oil is generally fluid.

Fixed vegetable oil occurs in plants, associated with mucilage, sometimes in the fruits, as in nuts; occasionally in the pulp surrounding the seeds, as in the olive; but most frequently in the seeds themselves, as linseed, rape-seed, &c. Some vegetable fixed oils, which are fluid in tropical climates, are solid in the usual temperature of this country, such as cocoanut oil; and it may here be observed, that the state of solidity or fluidity of all oleaginous substances depends merely upon the temperature to which they are exposed. All of them assume the solid state at a certain temperature peculiar to them; an oil that is always fluid in India may be generally solid in our climate. Several of the solid vegetable oils have received the name of vegetable tallow or butter. The degree of cold at which oils congeal or become solid varies extremely.

Of all the families of plants the cruciform is the richest in oleiferous seeds; and next to them are the Drupaceæ and Amentaceæ. Nuts contain half their weight of oil. The seeds of the Brassica oleracea and campestris one third; and the variety called colza in France two fifths.

588. We shall treat first of *animal oils* used for light; and afterward of *vegetable oils*.

Subsect. 2.—*Fish Oils.*

589. *The oils most extensively used in Britain for procuring light are the fish oils.* Oil is obtained from several species of fish, and these vary somewhat in their qualities.

590. *The best of these is spermaceti oil*, usually advertised as *sperm oil*. This is, as we stated when describing spermaceti, the oil which drains from the crude spermaceti found in the head of the spermaceti whale, and also from the fat or blubber.

When analyzed it is found to consist of carbon 78·00, hydrogen 11·80, oxygen 10·20. It affords a clear, bright flame, without smell, and it is, on that account, generally burned in Argand lamps in the best apartments in Britain; but several of the finer kinds of whale and seal oil, when purified by forcing them through animal charcoal, are often sold for it. The spermaceti whale does not confine itself to the polar regions, but is found in all latitudes, and abundantly in the equatorial regions, on the coast of Brazil, the Gulf of Guinea, the coasts of Australia, and Van Dieman's Land, and in great numbers on that of Japan. The sperm whale is gregarious, herds of four or five hundred sometimes congregating together; and the taking of them is accompanied with great danger. In 1836, 6083 tons of sperm oil were imported into London. The price having greatly increased of late, the consumption of it is much less, cheaper fish oils being employed, and likewise vegetable oils.

591. *Greenland oil*, or *common train oil*, is the produce of the whale called *Balæna Mysticetus*. The fat or blubber of this animal lies under the skin and over the muscular flesh; it is usually about six inches in thickness, but about the under lip it is two

or three feet thick. The whole quantity yielded by one of these animals ordinarily amounts to forty or fifty, and sometimes to eighty or more hundred weight. Its use in the animal appears to be partly that of poising the body of that enormous creature, and partly to keep its flesh warm in the cold regions which it frequents. Formerly, the boiling down the blubber into train oil was performed where the whales were caught; but of late it has become the practice to pack it up in casks after it is cut off, and to bring it home to extract the oil. In young whales, this fatty matter resembles hog's lard; but in old animals it is of a reddish colour. When the blubber arrives in England, it is generally somewhat rancid, and to separate the oil, it is put into a large reservoir that will hold about twenty tons, in the bottom of which there is a wire grating to suffer the oil to drain through and stop the blubber. The membranous matter that remains is called *finks*, and is burned into animal charcoal. The oil that is run out is led into another vessel, where it is left for two or three days to settle; and after that it is put into a copper and heated to 225°. This causes the mucilaginous matter to settle to the bottom, and destroys the rancidity of the oil. To prevent the adhesion of the mucilage to the bottom of the boiler, some water is poured on the top of the oil when it has cooled by drawing off the fire: the water passes down through the oil to the bottom, and, uniting to the mucilage, prevents its adhesion. The purified oil at the top is then run off into casks for use.

This oil is of a reddish or yellowish colour: when burned in common lamps, it gives out a strong, unpleasant odour, particularly if unpurified, and therefore is seldom employed within doors, but confined to street lamps and other out-door purposes. Burned in an Argand lamp, the oil gives no bad smell, but a quantity of oily matter collects upon the wick, which clogs up the passage for air, and impedes the combustion. By purification, indeed, it may be rendered more limpid, and its odour less offensive; but it is always inferior to spermaceti oil. By recent improvements in lamps, which will be described, it is burned without any bad smell, and without clogging the wicks.

592. *The whale fishery* is of great antiquity; and the Norwegians are supposed to have been the first who attempted the perilous enterprise of killing the whale. The Biscayans engaged in a regular whale fishery in the 12th century; but the whales then caught were of a small size, and were employed as food: whalebone appears to have been then used for the first time. Greenland whales now seldom frequent the Bay of Biscay, confining themselves to the icy seas, where their haunts are eagerly sought for. When the whale fishery was first prosecuted on the coast of Spitzbergen, the whales appeared in great numbers, and, showing no signs of fear, were easily taken; but as the animals began to experience the effects of the stratagems and power of man, they retreated, first to the open sea, and finally under the great banks of ice. Greenland whales are now becoming more scarce, probably on account of the great destruction made of them; and on this account train oil is more difficult to be procured. The polar regions in the southern hemisphere are now resorted to for the whale fishery. The invention of gas light, however, for lighting the streets, has much diminished the demand for whale oil.

593. *There are various other fish oils* used either for giving light, or for various manufacturing purposes.

Iceland whale oil, or fin-fish oil, from the *Balæna nordcaper*, also from the *Balanoptera gibba*. *Sea unicorn oil*, from the *Monodon vulgaris*, finer than any other kind of whale oil. *Porpoise oil*, from the *Delphinus Phocæna*, of a fine quality. *Swordfish oil*, from the *Delphinus gladiator*, of excellent quality. *Sea lion oil*, from the *Phoca leonina*. *Seal oil*, from the *Phoca vitulina*. *Morse oil*, or sea-cow oil, from the *Trichicus rosmarus*. For various manufacturing purposes, there are *shark oil*, from the barking shark; *cod oil*, from the liver of the cod; *herring oil*, obtained by pressing herrings when they are very plentiful; *conger oil*, from the conger eel; *pilchard oil*, by pressing that fish.

594. *Fish oil requires to be purified before it is fit for burning*. At first it is very thick; but, on standing, a whitish mucilaginous matter is deposited, and the oil becomes transparent. It is then of a reddish-brown colour, and has a disagreeable smell.

The modes of purifying it are, in general, kept secret by manufacturers; but the following processes have been practised with some success.

If one or two per cent. of sulphuric acid be added, the mixture assumes instantly a dark green or brown hue, and when allowed to stand quietly for some time, deposites a dark-coloured matter, which consists of a chemical combination of the sulphuric acid with a body thus separated from the oil, which becomes, in consequence, more limpid, and burns with a brighter flame, especially after it is washed with steam, and clarified by repose and filtration. Any remaining moisture may be expelled by the heat of a water bath.

Oil has been purified by agitating it violently with one sixth of spring water, and then letting it rest for 48 hours; the transparent oil will then be found swimming at the top, while all the feculencies will have subsided to the bottom with the water. Rape oil so treated has been found to burn as well as spermaceti. A churn answers the purpose

of performing the operation, with a cock to draw off the oil. Some use lime water in preference to that of springs.

Whale oil may also be purified without heat, by filtering several times through charcoal. For this purpose, some employ the long cylindrical bags used by the sugar refiners, which are made of stout canvass and lined with flannel, so as to admit of a thickness of an inch of powdered charcoal, which detains the impurities of the oil. After passing through this filter, the oil is put into a cistern containing water at the bottom to the depth of about six inches, in which blue vitriol is dissolved in the proportion of an ounce to every twenty gallons of water; this divests the oil of any remaining impurities, and likewise of the greater part of its unpleasant smell. It is farther cleaned by a second washing in another cistern of water, where it is allowed to remain for several days, and again it is filtered through charcoal, and lastly through flannel.

A patent has been taken out for clarifying oil by means of heat: the oil is put into a tin kettle, which is fixed within another somewhat larger, and having water in the manner of a glue pot; or steam may be introduced between the two: a close case is fitted on, and openings are made for supplying water and oil, and also for placing a safety valve. By keeping the oil some time in a moderate heat, a portion of the mucilage and other useless ingredients rise to the surface as scum, and another coagulates and sinks to the bottom, the oil remaining pure. One advantage which this method has over that by exposure to the air and sun is, that it can be practised at all times and states of weather.

Dossie's process for purifying fish oil is as follows: Add one ounce of pulverized chalk and half an ounce of slacked lime to a gallon of crude fetid fish oil, then stir in carefully half a pint of water. The stirring is to be repeated after an hour has elapsed, and at other convenient intervals, for two or three successive days: then add an ounce of pearl ashes, dissolved in four ounces of water, and continue the stirring at intervals, for some hours. Next add a solution of two ounces of salt in one pint of water, and agitate the mixture occasionally during the next two days. Now the whole ought to stand still for several days, when the brine will separate from the oil, which will be greatly improved both in smell and colour. Should a greater degree of purity be required, the proportion of pearl ashes ought to be increased, and the period intervening between the addition of the salt water prolonged: lastly, if the same operation be repeated, and the quantity of ingredients reduced one half each time, the oil may be brought to a very light colour, and its smell rendered equally sweet as the common spermaceti. By this treatment, it is said, the coarsest cod or seal oil may be made to burn well.

The following process for purifying fish oil is given in "Brewster's Journal:" Dissolve about one pound of chloride of lime in about one gallon of water, draw off the clear solution, and mix it thoroughly with about one hundred weight of the putrid oil; then add about three ounces of sulphuric acid, previously diluted with sixteen or twenty parts of water, and boil with a gentle heat till the oil begins to drop clear from a spatula. After the ebullition is finished, draw off the oil into a cooler, and allow it to remain at rest for a few days. The quantity of chloride of lime must be varied according to the putridity of the oil. By this the oil will be deprived of its disagreeable odour.

595. *Oil for the purpose of artificial light should be kept from exposure to the air.* Fat oils may be preserved fresh for a long time in vessels perfectly closed; but if exposed to the air, they thicken, and at last become rancid, by the formation of a peculiar acid called the sebacic acid, in which state they are less combustible, and give an offensive smell. This may be removed in a great degree, and the rancidity destroyed, by boiling the oil with a little water and a little magnesia for a quarter of an hour, to neutralize the acid. The boiling must be continued till the oil will no longer redden litmus paper.

[The following method of purifying whale oil may be regarded as a discovery peculiarly American, and is now very generally practised by manufacturers in this country:

First, it is subjected to filtration through a strainer made of linen canvass, and suspended by a frame over a large trough, by which process what are called "foots," technically, are removed. It is then put into kettles containing from 1 to 300 gallons, and subjected to the process of *bleaching*, by the following recipe, for which the editor is indebted to William A. Swaine, Esq., of the firm of Brooks and Swaine, Front-street, New-York, and is now generally adopted, though once kept profoundly secret, and made a source of emolument to the initiated.

Preparation of the Potash for bleaching Oil.

Take 100 lbs. of the best potash, known as *first sorts*, and dissolve in 15 gallons of pure spring or rain water, which must be boiled down until the quantity is reduced to 9 gallons.

Into a boiler holding 100 gallons of either whale or sperm oil, at the temperature of 60° F., pour 2 gallons of the liquor prepared by the fore-mentioned process, and let the whole be thoroughly stirred for 15 minutes. Then apply heat until the whole is raised to 80 or 90° F.: meanwhile, the gradual stirring of the mass is indispensable, to pre-

vent any settling, which would defeat the process. So soon as the temperature is at 90°, the fire beneath the boiler should be removed or extinguished, and the stirring be discontinued. In about six hours the whole will be found white and transparent.

In the large manufactories steam is employed for regulating the temperature, which is found to be every way preferable.

Spermaceti oil thus treated is found to be rendered more highly inflammable than in the crude state, besides being thus rendered pure, transparent, and of a beautiful colour.

For the following interesting details in relation to *lard oil*, which is deservedly becoming an object of great attention and interest in the United States at present, the editor is indebted to "Improvements in Agriculture, Arts, &c., of the United States, by Hon. Henry L. Ellsworth, U. S. Commissioner of Patents."]

LARD OIL, ETC.

The subject of the manufacture of OIL from CORN and LARD was introduced to the notice of the public in the report of 1842. As corn oil has heretofore been connected with distillation, although it is easily made and answers a good purpose, less attention has been devoted to it. It has been suggested, on good authority, that it can be gathered from the mash which is prepared for fermentation for feeding swine. If this should be confirmed by farther experiments, as it would not be liable to the same objection urged against the former, the manufacture of spirituous liquors, it may hereafter be carried on to a great extent. No doubt seems to be entertained of its value for burning, and all other purposes to which oil is applied but painting.

Much interest has been felt in the subject of oil from lard, and the almost daily inquiries respecting its process of manufacture, &c., and its close connexion with the question of disposing of our agricultural products, forms a reason for giving it a more extended consideration in these remarks. Complete success has attended the enterprise. Several large factories for the manufacture of this oil have been some time in operation in Cincinnati, and thousands of gallons are daily prepared for home consumption and exportation. It is also carried on at Cleveland, Ohio; Chicago, Illinois; Burlington, Iowa; Hannibal, Missouri; and other places both in the Western and the Atlantic States.

It is considered much superior to olive or sperm oil for machinery, and for the manufacture of woollens, &c. It can be furnished, also, at half the price, and therefore it will doubtless supersede that article of import. As it contains less gelatin than other oils, it is found much better for combing wool, for which purpose a single factory wished to contract for 10,000 gallons from one establishment. It is also undergoing trial in England; and if it succeeds, of which there can scarcely be a doubt, large orders for it may be expected, or, at least, the American lard itself, which pays a less duty, will find a ready market. An order for 600 gallons, with this view, has already been received for the use of a cloth factory in Huddersfield, England. It has also been stated in the journals that a gentleman is about taking out a large quantity, recently ordered from the West, for the purpose of trying it there as an article of trade; and it has lately been stated that 16,000 lbs. have been sent from Cincinnati to England. Repeated experiments, too, have shown that for the purpose of combustion no oil is superior. It is important, in trying it with this view, to obtain a good article, manufactured from good lard, and not from the dark-burned, which creates smoke and clogs the flame. For want of sufficient care in this respect, some have no doubt met with disappointment in their attempts to substitute this oil for sperm oil in the lamps.

The following are given as the relative constituents of lard oil and sperm oil, in 100 parts of either:

	Carbon.	Hydrogen.	Oxygen.
Lard oil	79.03	11.422	9.548
Sperm oil	79.05	11.6	8.9

It will thus be seen that the difference in carbon is only 3.00; about the same in hydrogen; while in oxygen it is about 4.10 in favour of the lard oil. The large quantity of carbon proves that it may be relied on as a material for giving light, as it is well ascertained that whenever carbon predominates in an animal oil, the article is capable of a high degree of luminous power. Experiments have been made by Mr. Campbell Morfit, of Philadelphia, which may be found mentioned on page 155. These resulted in favour of lard oil. About 60 lbs. in 100 of good lard, in tallow only 28 is oil; and the processes of manufacture resorted to show that it may be made a profitable business. Large orders have already been executed at the West for this oil, to be used in the Eastern States. The heat of lard oil for the blow-pipe has been found to be much greater than that of sperm. Lard itself melts at 82° of Fahrenheit; its specific gravity at 60° is 0.938. Lard crystallizes in small globules; sperm in flakes or scales. It is soluble in boiling alcohol. The proportion is 80 gallons of lard to 1 of alcohol. The application of stearin for candles, which was also alluded to in the report of 1842, promises greatly to reduce the price of that article, as will be seen by Mr. Morfit's let-

ter, already alluded to, on page 155. He thinks that the price of such candles, equal to spermaceti, may be eventually reduced to 12½ cents per pound.

As the capillary attraction of lard oil is not so great as that of sperm, it is recommended that the form of the lamp should be such as to bring the bulk of the oil as near to the point of combustion as possible.

It is also recommended that the tube should be filed thinner at the top where the wick is inserted, to prevent the escape of heat. Various lamps have been constructed for burning lard, as well as lard oil, which have been found to answer very well. The solar astral lamp, for this purpose, affords a light unsurpassed by any other for brilliancy and quality of luminous power; and the letter of Mr. Milford, collector of Cleveland, Ohio, which will be found on page 160, shows that the burning of this oil has been introduced with entire success into the lighthouses on Lake Erie. An objection has been made against lard oil, that it is not capable of being preserved in a liquid state in cold weather; but, by a process similar to that by which the winter sperm is prepared, lard oil can be made which will not chill at 30° Fahrenheit.

The importance of this application of lard can scarcely yet be realized. Vast quantities of the oil can be manufactured at the West. Indeed, there is hardly any assignable limit to the power of production of the article, so that, while the demand continues, the business may be conducted profitably. The immense herds of swine which can be suffered to range over the lands adapted to them, and gather their food from mast, as well as the surplus of corn, wheat, potatoes, &c., on which they may be sustained, admit of the manufacture being carried on to almost any extent.

The proportion of lard to the whole hog is about 60 per cent., after taking out the hams and shoulders, or taking out the hams only; the estimate for hogs of the best breeds, and so fed as to produce the greatest quantity of fat, is 70 per cent. As the object is not, in this case, to make pork for food, the objection against those species of nuts, and other modes of feeding which render the animal more gross and oily, is obviated; and it has been proposed to feed out oil-cake to swine, to increase the proportion of oil.

An important letter, in relation to the manufacture of lard oil, &c., will be found, together with Mr. Morfit's account, before mentioned, on pages 155 and 160, the necessity of the publication of which is every day becoming more and more apparent from the continual demand on the Patent Office for copies of the mode of extracting the oil from lard. The specification of one manufacturer, who has patented his process, has also been added for the same reason, as numerous copies are continually requested (p. 161).

By a new process of steaming (a very simple method, a description of which will be found in the letter of Mr. Stafford, on page 160), it appears that the whole of the lard or oily matter in the hog, or of tallow in cattle, may be obtained; while the danger of burning (common in other modes) is avoided, the consumption of fuel lessened, and the degree of pressure required not so great as otherwise. It will be recollected that, while conducting the manufacture of lard, the other parts of the animal, as the hams and shoulders, may be turned to profit. Besides these, also, the hides may be tanned by a cheap process; and the bones, which are worth half a cent per pound, may be calcined and made into animal carbon, for which they are said to be worth, in this calcined state, two and a half cents per pound.

Oil is likewise made of the SUNFLOWER—35 gallons to the acre. The cultivation of the *castor bean* continues to be carried on with increasing success for the manufacture of castor oil, which may also be turned into stearin and oil for burning. A single firm in St. Louis has worked up 18,500 bushels of beans in four months, producing 17,750 gallons of oil, and it is stated that 800 barrels have been sold at $50 the barrel. This oil, likewise, admits of being prepared for machinery, soap, &c., and it is much more soluble in alcohol than lard. A new experiment, too, as to the introduction of *rape seed*, for the same purpose, promises much success, as it is found that rich ground will produce from 25 to 40 bushels to the acre. Ten quarts of oil may be obtained from a bushel of the seed. Oil-cake is worth, per bushel, about the same as oats. This oil sells for from 75 cents to $1 the gallon.

A more beautiful article of lard is now also manufactured, which is of the purest white, and much harder than the ordinary kind, and which thus possesses additional advantages for exportation, as it will bear being sent to the warmer climates, and can be prepared by a rapid process, which costs not over half a cent the pound. The details of this will be found in Mr. Stafford's letter, previously referred to, page 160.

These various articles just mentioned have been brought together, as they are of a kindred character, and constitute a branch of business which is probably destined to become a most important one in our country. It may be well, indeed, to look at this subject a little more closely, and in detail, to ascertain the means we have of future production, as this lard is one of the articles on which the duty in England and France is so low as to bear exportation. In the first place, What are the materials of manufacture at home? The live animals can be raised at little comparative expense; and this business, as we have before said, can be carried on to almost any extent.

Few persons who have not taken the trouble of calculation are aware of the results of an examination into this subject. It would be thought strange, were the assertion made that the export of oil, pork, and lard, were a market opened to us, might be equal to that of our heaviest staples—even to that of cotton; but it is believed that it can be strictly demonstrated that not only this is true, but that it might reach in value beyond all the exports from this country the past year. The calculation is an easy one: pork can be raised in all the states; and wherever there exists mast and wild vegetable roots, the expense is very trifling; for it will be remarked that, for the purpose of making oil, it is immaterial how great is the degree of oleaginous food which is given to swine. Beech, oak, hickory, and walnut, all furnish excellent food. Corn, too, may be raised on the prairies at $3 per acre, standing in the field, where the swine are turned in to feed; making the cost six cents per bushel, allowing (which is a fair estimate) 50 bushels to the acre. If any one doubt the practicability of this, it will only be necessary to consider the fact, that one man can attend to 40 acres, which, beginning early in the season, he can plough with horses at the rate of two acres per day, plant with the corn-planter from five to ten acres a day, and then till it with the cultivator. At $3 per acre, the supposition before mentioned, this would make his receipt for the three and a half or four months employed, $120, or $30 to $35 a month, for wages, expenses, &c. As a farther means of keeping the swine, rye may be sown on the ploughed sod to furnish winter food; and, by taking them off in the spring, a crop of rye may be raised, making a good sustenance for the swine, they being turned in to feed upon it standing after it is ripe. It has likewise been found that, since the animals scatter some of the grain on the field, the same piece of ground will yield two or three seasons without any extra ploughing. It may also be remarked, in passing, that rye pastures are found to be excellent for wintering cattle without injury to the crop of grain, if the stock is taken off early in the spring.

Such, then, are the facilities for raising swine. We can, however, carry the calculation farther. The number of swine reported in the census for 1839 is over 26,300,000. There is reason to believe that the number has very greatly increased in many of the Western States since that time. Thus, it is stated that in Michigan, in 1837, when the state census was taken, the number of hogs reported was 109,096; in 1839, by the United States census, was reported the number of 342,920, being an increase, in only two years, of 232,535, or more than 100,000 in a year. It is supposed, by a writer who appears to be well acquainted with the products of that state, that in 1841 there were not less than 700,000 swine in the state; according to which ratio, there would probably be now over 1,000,000. The whole number in the United States, therefore, estimated simply at an increase of five per cent. the year, would now exceed 30,000,000. Taking this, therefore, as a fair estimate, and allowing that one half of them should be fatted to average 300 lbs.—and for the purpose of lard they would need to weigh 300 or 400 lbs.—we should have the following results, viz., 15,000,000 hogs, weighing 4,500,000,000 lbs. Deducting the two hams, which might be estimated at 20 lbs. each, allowing, also, a loss of one third in curing, is equal to 400,000,000 lbs.; and trying up the remainder, equal to 39,000,000 lbs., on which 60 per cent. of lard might be obtained, gives 2,340,000,000 lbs. of lard; and, since 8 lbs. of lard equal a gallon of oil and stearin combined, this amounts to 292,500,000 gallons, which is equal to 9,285,714 barrels. This is more than twenty-five times the amount of sperm and whale oil annually brought into the United States, including, also, palm and olive oils. Allowing 40 lbs. for the two hams, as we have seen, gives 400,000,000 lbs. Estimating, now, the lard oil and stearin combined at 50 cents per gallon, and the hams at 6 cents per lb., we have the enormous sum-total of $170,250,000. This would probably equal over three times the export value of cotton at the present low price, or perhaps even the whole crop for this year (1843); as the whole crop for 1842, according to the best estimate which a careful examination enables us to make, amounts to 683,333,231 lbs., which, at 6½ cents per lb., is $44,416,650. This, too, is nearly double the whole value of our exports, as appears from the report of the Secretary of the Treasury.

It is, indeed, admitted that we have not, and probably may not for a long time, if ever, have so large a quantity of lard and hams for exportation; but the supposition is only made to show the capabilities of the country in this respect. There is not the slightest difficulty, were the effort made, in doubling the number of swine in the United States, so that the whole surplus above the present number could be thus used for the manufacture of lard and oil. Besides, the articles mentioned in the case supposed above do not require salt, and may be preserved with great ease, as well as allow the animals to be killed earlier, so as to secure a full market; and the former is a consideration of no small importance, especially in portions of the country where salt is high. It will be found more profitable at present, at the price of lard and oil abroad, to use the whole hog for this purpose, the hams and sides excepted. It should be mentioned, too, here, that in the above calculation no account has been taken of a variety of articles which are worth something, and which might aid to defray the expense of the preparation of the lard and hams. Thus, as to the hides, they may be taken off

with the hair, at about the same expense as by scalding, and may be tanned at $5 per dozen, or preserved by sprinkling the fresh hides, spread out smooth, with salt, laying one over another, flesh sides together, until there are fifty or sixty together. They can then remain in this state until cured, and may be rolled up and transported to any market. The leather of these hides, when tanned, is used not only for saddles, collars, trunks, but also for binding books—a substitute for Russia leather—and many other purposes. The bristles will pay, in part, for preparing the hides for the market. Hides, when well curried, will bring, it is said, from $15 to $50 per dozen. Hams, too, are said to be better when cured without skins, as the gum of the skin injures the taste of the meat, and retards the salting operation.

It may be remarked here, also, that a demand for oil and candles from lard will, of course, greatly advance the price of pork for consumption, and thus, while a new staple is created, an old one is greatly improved. An increase of only one per cent. per pound on swine slaughtered in the United States will make an aggregate in value of at least $30,000,000. This sum would not, indeed, be actually realized in cash, as little pork, comparatively, is now sent to market, but is consumed by the family where it is raised. *That country which produces beef and pork to most advantage, and especially if wheat is also added, must excel in agricultural profits.*

FOREIGN MARKET.

In looking at the details just given, evidently proving the immense resources our country possesses in these products, as they may properly be termed, of her soil, the question naturally arises, Is there any demand for them abroad? It can be shown, it is believed, that this demand is greater than has been supposed, and that it seems likely to increase. A part of the bearings of this subject will be brought up in connexion with another portion of these remarks; but it may be well here to observe, that from New-Orleans the export of lard for the years 1841 and 1842 to foreign ports was 172,260 kegs, while that to the ports of the United States was over 260,000 kegs.

To Cuba, whose exports to the United States have much exceeded her imports from this country, as appears from the report of the commercial relations of the United States by the Secretary of State, there were shipped, during the year 1838, 5,884,028 lbs., valued at $368,146, at a duty of four cents per lb. The desire to obtain lard from abroad has induced England to admit it into her ports at less than half a cent per lb. duty when taken in American vessels, or, when taken through the Canadas, at less than one eighth of one cent per lb. The duty in France is a little more than two cents per lb., to her colonies not more than one half a cent per lb.; when sent to the Netherlands and Belgium, one mill per lb.; in Texas it is free; in Venezuela, four cents per lb. Large quantities of the olive oil, for which lard can be substituted, are used for making soap. In Marseilles, it is stated, on good authority, that not less than 17,000 lbs. are thus used daily.

Kensington, Philadelphia, January 6, 1842.

Sir—In answer to your inquiries upon the subject of converting lard into oil, and also into concrete forms for the manufacture of candles, I hasten to say that, having been, and still continuing very much engaged in chemical processes upon lard, I am not able, in the short time I can devote to the subject of your letter, to give you the ample information which is desirable, and which, if more at leisure, I could readily furnish. I, however, write off, *currente calamo*, the result of some of my experiments in this branch of inquiry, which perhaps may be serviceable. The article of lard offered for sale in the market for domestic use, and now about to be so much in demand as material for the manufacture of lard oil and candles, is prepared from the adipose matter of the omentum and mesentery of the hog, by freeing it with the hand from the membranous substance connected with it, washing with water until colourless, and melting with moderate heat, continued until the dissipation of all moisture, which fact is known by the transparency of the melted matter, and the absence of *crepitacula*, when small portions are thrown on burning coals.

The chief source of this article is the West, from whence it is brought in kegs of from 40 to 80 pounds each; when fine, it is perfectly white in appearance, and rather inodorous, nearly tasteless, and, at moderate temperature, of a soft consistence, insoluble in water, and but partially so in alcohol. When exposed to the air, it becomes rancid by the absorption of oxygen; this rancidity, engendering a liability to injurious reaction, renders it unfit, in that state, to be used in pharmacy as an ingredient of cerates and ointments, of which it forms the principal part. For this purpose, therefore, it should be kept in close vessels, free from contact of air.

Lard, as well as nearly all other fixed oils and fats, is composed of three proximate principles: two solid, called stearin (from στέαρ, tallow) and margarin (from μαργαρίτης, a pearl); and one liquid, of which there are two varieties, called olein (from ἔλαιον, oil).

Stearin characterizes, for the most part, animal fats. Margarin, vegetable and olein,

is almost universally present in both. The two fats are essentially different from each other. Margarin is distinguished by its greater fusibility, its being more soluble in cold ethers, and the necessity of evaporation to procure it from such solution, while the stearin drops spontaneously during refrigeration.

Berzelius thinks these principles not identical in different oils, as their points of congelation and liquefaction vary according to the substance from which they are derived. Pelouze and Boudet, however, attribute the variable fusibility of the margarin and stearin of fats to the existence of definite combinations of margarin and stearin, respectively, with olein, and think that each of these principles, in a state of purity, is probably the same, from whatever source obtained; and to prove which, they assert having found the same margarin in palm oil as in human fat. But in oils, and particularly the vegetable, their investigations evinced the presence of two oleins, distinctive in their characters: one more soluble in different menstrua than the other, and with a less proportion of hydrogen, besides other properties inherent in the one not possessed by the other, more than the mention of which would occupy too much space and time.

The ultimate principles of fixed oils are carbon, hydrogen, and oxygen, the hydrogen being in much larger proportions than is necessary to form water. To this predominance of hydrogen is attributed the readiness with which they burn with flame, that property procuring for them all their usefulness as means of illumination or artificial light.

Stearin, the first named of the constituents of oil and fatty matters, is a concrete white substance, insipid and without smell, fusible at 110° Fahrenheit, insoluble in water, and but partially so in alcohol.

Margarin, present in lard and most other fats, and forming by far the greater portion of olive oil, is more fusible than stearin, and, as its name indicates, of a pearly appearance, possessing, also, other properties different from stearin, mention of which has been made above. Olein, the oily principle formerly called elain, when pure, is quite colourless, and in some degree has the appearance of vegetable oil, liquid at 60° and congealing at 32° Fahrenheit, and, though not becoming rancid by exposure, acquires viscidity. The relative proportions of all these three principles are different in different fats.

Nearly all kinds of fat, under proper circumstances, are capable of combination with alkali, by which union the principles thereof are changed. By this reaction, they undergo *saponification*, and are transmuted, not by the absorption of any foreign substance, but by the union of the elements of a small portion of water into three peculiar acids, *stearic*, *margaric*, and *oleic*, which unite with the salifiable base and into a peculiar sweet principle, glycerin (from γλυκυς, sweet), which, in remaining behind, is not saponified. Of this sweet principle, there are formed about three during the saponification of every one hundred parts of lard or tallow.

Hog's lard, in its natural state, Chevreul says, has not the property of combining with alkalies, but acquires it by experiencing some change in the proportion of its elements. This change being induced by the action of the alkali, it follows that the bodies of the new formation must have a decided affinity for that species of body which has determined it. These acids, generated during saponification by the action of the alkali, called adipose or saponic acids, are, when *solid*, in appearance like wax or spermaceti; when *liquid*, they appear as their oils, mostly fusible at temperatures below 212° Fahrenheit.

The oleic, being generally mixed with that portion of margaric which is liquid at the time and temperature of its preparation, is used sometimes as lamp oil, but mostly for the manufacture of soaps; while the remaining small portion of margaric, being of a consistence sufficient to retain it with the stearic, is allowed to remain with that body, which, when used for candles, experiences no great disadvantage by its presence. Stearic, the most important, and by far the most characteristic product of the saponification of lard, tallow, and other not easily fusible fats, is the one of which, at your request, I am to speak in detail; an article the use of which for making candles bids fair to be in this country most extensive. The consequence which this branch of manufacture is about to assume is no greater than its merits should obtain for it. Independent of all other advantages, the great reduction which it will occasion in the price of an article of such general and necessary use in domestic economy is alone sufficient to procure the attention which the subject does and will receive. Inferior in no degree to sperm, both as regards quality and appearance, the stearin candles have the advantage of greater cheapness, as they can be made, even by the English mode, hereafter given, at a cost of at least 20 per cent. less than sperm. The increasing importance of this subject induced my attention to it some eight or ten months previous, since which period my whole time has been devoted to its examination. The result of my investigation is a process entirely different from all others, to be executed with so much facility, and with so little cost of time, money, and labour, that I expect to make by it candles, in appearance and quality, as perfect and good, if not better, than sperm,

and which, when *retailed*, even at as low a price as 18¾ cents per pound, will afford a remunerating profit to the manufacturers, and a profitable commission to the vender. I mention this price in consideration of the present rates of lard, the supply of which, owing to the unexpected requisition for this purpose, is at present totally inadequate. When, however, this is removed by the increased supply which the producers will see it is their interest to furnish, the price of the material will be in a few years much lower: this, and the improvements which by that time I shall have made in my mode, will, I expect, enable me to manufacture candles at a price so reduced as to entitle them, when these superior properties are considered, to the substitution for the much-used but unpleasant mould and dipped candles.

I would willingly communicate fully the manner of conducting the process, but, having been at a great expense of time, money, and anxiety, I have determined to remunerate myself by carrying it into practice; and, for this purpose, I am now arranging apartments in my laboratory, and hope, by the coming spring, to have for sale, in quantities, candles as good, or better, than the sample I sent you some weeks since.

I have spoken of lard, because this article will, without doubt, be the material from which to make these candles, both on account of the facility with which it can be produced in quantities, its comparative cheapness, and the profit on its oil, yielded in a preparatory stage of the process for manufacturing the stearic acid, of the substance of which the candles are made. This oil, now largely in use, under the name of lard oil, is nearly pure oleic, its only admixture being small portions of margaric and stearin, with which it becomes connected during preparation.

Its great superiority over sperm oil has caused it to be extensively substituted for that article, for lubricating the joints of machinery, and for manufacturing purposes generally. As a burning fluid, it has proved itself equally good; and in corroboration of this is my experiment with lamps of eight ounces' capacity, previously cleaned and new wicked for the purpose. This experiment was frequently repeated, with the same results. In one lamp was pure sperm; in the other lard oil, of only a fair quality, burned under the same circumstances. The consumption of oil in both was equal; the quantity of light equal; the flame was different, that of the lard oil being of a reddish hue, and not so transparent as sperm. The lamps were of glass, and such as are ordinarily used for burning common oils. There is an erroneous idea abroad that it requires lamps of a peculiar construction to consume this oil. It is not so, for I use in the laboratory lamps of the commonest make. If, however, the notion will be persisted in, instead of purchasing an expensive burner, all that is necessary is to have substituted, by any coppersmith, for your tin tubes in the lamps you may have those of copper, filed off quite thin at the top, where the wick projects through, so as to prevent the passing off of too much heat; then the lamp will answer to burn lard as well as oil. The price of lard oil being at all times about 25 cents less per gallan than fair sperm, and being equally good, preference should therefore be given to it, both because of its economy, and of being a domestic production. It may be as well to mention that there are lard oils of various qualities; that prepared from dark-burned lard is not so good for *burning*, because of its causing, after several hours' burning, a crust on the wick; and, as there has been a quantity of this kind of lard in market, and bought for manufacturing the oil, it is not surprising that there should be a slight prejudice against it as a burning fluid. This prejudice, however, is always removed by the use of that made from pure white lard.

It may be as well to say here some few words in relation to the burning of the lard. To further the consumption of this article, there has been introduced, by persons having at heart their own more than the interest of the community, an expensive lamp, which they advertise as being peculiarly adapted for this purpose. The substitute of lard for *its* oil possesses no advantage, either as regards price or convenience; the use of the latter being so economical, and much more cleanly, besides its not requiring additional expense for a peculiar kind of lamp. The liability of these burners to smoke, and other disadvantages, will, upon trial, convince any one of their inconvenience; and if any other fact or corroboration is requisite, it is only necessary to say that, notwithstanding the grand display of the article in full flame at the last exhibition of the Franklin Institute, and the ample opportunity thereby afforded to judge of their deserts, so destitute were they of merit, as not to have elicited even a passing notice or mention from the committee. If, however, lard is preferred to its oil, why go to the unnecessary expense of a new lamp, when any one you may have will answer fully as well, with the tubes altered as above directed? Farther still, in proof of my assertions about the false economy of burning lard in preference to the lard oil (the lard oil, as my experiment before mentioned proves, being equal to sperm), I here insert the result of Harris & Co.'s experiments, cut from a Boston paper last week:

To the Public.

As much has been said, of late, respecting lamps, oil, and lard, the subscribers have caused a very accurate experiment to be made, whereby the economy of oils and lard,

producing light in the solar and careel lamps, might be tested. These two descriptions of lamps were selected for the purpose, as they may be fairly deemed superior to all others in points of economy and safety. Wishing to satisfy all interested in the subject, and who may not have the conveniences necessary for the test, we shall give particulars of the experiment made November 10, 1842.

The solar lamps, of the same size and construction, and one French carcel lamp, were used.

Time of burning, four hours.

No. 1 denotes a solar lamp filled with whale oil.
No. 2 " solar " " " sperm oil.
No. 3 " carcel " " " sperm oil.
No. 4 " solar " " " hog's lard.

Weight of whale oil, 124 ounces per gallon, quality indifferent.
Weight of sperm oil, 120 ounces per gallon, quality good.

Lard of best quality, fresh and sweet.

Nos.	Length of Shadow.	Square Inch.	Quantity burned.	Cost per Gallon.	Cost of Quantity burned.	Equal to
No. 1 . . .	37.2 inch.	1383.84	8.5 oz.	50 cts.	3.42 cts.	3 42.100 cts.
No. 2 . . .	38.3 "	1466.89	9 5 "	80 "	6.33 "	6 33.100 "
No. 3 . . .	32.6 "	1062.76	8.25 "	80 "	5.50 "	5 50.100 "
No. 4 . . .	33.2 "	982.40	9.25 "	8 "	4.62 "	4 62.100 "
	27.25 "					

Each lamp was made to give as much light as possible at the commencement of the experiment, and the strength of shadows then measured. Nos. 1, 2, and 3 maintained the same degree of light during the whole time of burning. The light from No. 4 had perceptibly decreased in two hours, and, at the close of the experiment, had receded upward of 16 per cent. Consequently, the mean quantity of light given during the four hours is taken in estimating their relative powers.

No. 1 (whale oil), compared with No. 4 (lard), gave 105 per cent. more light in proportion to its cost.

No. 1 (whale oil), compared with No. 3 (sperm oil), gave 111½ per cent. more light in proportion to its cost.

No. 1 (whale oil), compared with No. 2 (sperm oil), gave 75 per cent. more light in proportion to its cost.

The following table shows the expense of burning each of the above lamps one hour, omitting fractions of mills, and stating the comparative quantities of light in whole numbers:

No. 1, 8 mills; light equal to 12.
No. 2, 15 " " 14.
No. 3, 13 " " 10.
No. 4, 11 " " 9.

The results stated in round numbers, showing the cost of each burning a given time, estimating the amount of light and cost of materials, are as follows:

Whale oil, in solar lamp, Argand burner, 100.
Sperm oil, " " " 175.
Hog's lard, " " " 205.
Sperm oil, in carcel, " " 211.

Much care was taken in weight and measure of the materials, and the judgment of several persons accustomed to such experiments was taken in adjusting the shadows, and the calculations we believe to be correct. This any one can verify, as the elements are all stated above.

We feel justified in recommending *the use of the best winter-bleached whale oil in the solar Argand lamp*, whereby the best artificial light now in use will be produced.

HARRIS, STANWOOD, & Co.

20 Tremont Row, Boston, December, 1842.

The mode now adopted for the preparation of this oil is that of graining the lard in a suitable and well-known manner, by which process the separation of the olein from the stearin is rendered more easy. This separation is effected by pressing the grained matter, enclosed in canvass bags, by means of a powerful press of proper construction. In this way, all the olein or lard oil is driven out, together with a small portion of margarin and stearin, not, however, in sufficient quantity to injure the oil. What remains in the bags (the stuff of which, after proper preparation, the candles are made) is the white constituent of the lard—stearin, with small portions of margarin and olein, remaining with it—the removal of which (the press not being able to effect) must, in order to procure good candle material, be produced in some other way. To effect this, I have (as before stated), after much trouble and patient investigation, discovered an economical mode, and which (as I intend carrying it into practice immediately) I shall not make known, but will substitute therefor that practised in England, and which is

found to answer admirably, the product thereof having so handsome an appearance, and being of so good a quality, as to cause it difficult to distinguish it from the most refined wax. This fact of their handsome appearance is confirmed by the following paragraph, cut from a paper some days since:

"ACCIDENTAL POISONING.—It is well known that a salve, for the cure of chaps and wounds, is often made of virgin wax and oil; and some families, who live at a distance from an apothecary, make this medicine, at the moment it is wanted, by taking a wax candle and melting it into oil. In employing this remedy, made of a candle, a person is said to have been recently poisoned in France. The reason of it is this: candles are now no longer made of wax, but of suet, from which oil has been extracted to grease wools. This suet, in order to form candles, is combined with a great quantity of arsenic. It is, therefore, not astonishing that arsenic, which penetrates even by friction, can have a poisonous effect when applied to the raw flesh."

The advantage which my mode possesses over this is its greater economy, both in cost and time, of preparation, while the product is equally good as that by the English, which is as follows: Tallow lard, or the solid part of lard, after the separation of its oil or any fat, is boiled with quicklime and water in a large vat, by means of perforated steam pipes distributed over its bottom. After several hours' active boiling, the combination becomes sufficiently complete. The stearate thus formed is allowed to cool, until it becomes a concrete mass. It is then to be dug out, transferred to a suitable vessel, and decomposed by a sufficient quantity of sulphuric acid. This decomposition of the soap, says the patentee, should be made in a large quantity of water, kept well stirred during the operation, and warmed by steam introduced in any convenient way. When the mixture has stood sufficiently long, the acid of the fat or tallow will rise to the surface, and the water, being drawn off, will carry the alkaline or saline matter with it; but if the acids or tallow should retain any portion of the salts, repeated portions of fresh water must be added to it, and the whole well agitated, until the acids have become entirely freed from alkaline matter.

The washed mixture of the three acids—stearic, margaric, and oleic—is next drawn off into tin or other suitable pans, and allowed to cool, and then reduced to thin shreds by a tallow-cutter—an instrument used by tallow-chandlers. The next step is to incase the crushed mass in canvass or caya bags, and then submit it to the action of a powerful hydraulic or the stearic cold process—a machine made for the purpose. By this means a large quantity of the oleic acid is expelled, carrying with it some little of the margaric. The cakes, after considerable pressure, are then taken out, and again subjected to the action of steam and water; after which, the supernatant stearic acid is run off into pans, and cooled. The cakes are then reduced to a coarse mealy powder by a rotary rasping machine, put into strong canvass bags, and submitted to the joint action of steam and pressure, in a hydraulic press of appropriate construction, called Maudlay's stearin cold press.

By these means, the stearic acid is entirely freed from oleic acid. It is then subjected to a final cleansing in a tub with steam, melted, and cooled in clean vessels. These cooled masses, owing to their crystalline texture, are unfit to be made into candles. It is therefore necessary, in some way, to remedy this. The French do so by crushing the masses, and pressing with them small portions of arsenious acid. This, however, is an injurious and reprehensible admixture, not only on account of the liability of such accidents mentioned in a previous paragraph, but because of the volatility of the arsenious acid, causing the atmosphere, in a room where these candles have been burned, after a short time, to be not only disagreeable, but deleterious to inhale.

This assumption of crystalline form I prevent without the use of this poisonous substance, merely by a proper and peculiar arrangement in the concluding part of the process. The wick to be used in the manufacture of these improved candles is to be made of cotton yarn, twisted rather hard, and laid in the same manner as wire is sometimes coiled round the bass strings of musical instruments. For this purpose, straight rods or wires are to be procured, of suitable lengths and diameters, according to the intended size of the candle about to be made; and these wires, having been covered with cotton, coiled around them as described, are to be inserted in the candle-moulds as common wicks are; and, when the candle is made and perfectly hard, the wire is to be withdrawn, leaving a hollow cylindrical aperture entirely through the middle of the candle.

I have now given you what information my leisure has allowed to prepare. I could extend my remarks, but have not now the time.

With the hope that this summary will answer your purpose, I remain yours respectfully,

CAMPBELL MORFIT, *Manufacturing Analytic Chemist.*

Washington, January 18, 1842.

SIR—In answer to your commun cation of yesterday, I beg leave to say that, in obedience to instructions received from the general superintendent of lighthouses on the

lakes, I procured, in the month of November last, a sample of lard oil manufactured in Cleveland, which was used in the lighthouse at Cleveland as an experiment. It had a fair trial, being placed in the centre lamp; the others were filled with sperm oil. The lard oil was found to give as brilliant a light, and burn equally well with the sperm. During the night, the lamps containing the sperm oil were trimmed twice; the one containing the lard oil was not trimmed. On examining the lights in the morning, at the time for extinguishing the same, the lamp containing the lard oil was found burning equal to those containing the sperm oil.

I have no hesitation in saying that I believe winter-pressed lard oil will burn equal to winter sperm oil.

I have the honour to be, very respectfully, your obedient servant,

WILLIAM MILFORD, *Collector of the Customs, Cleveland, Ohio.*

Hon. H. L. ELLSWORTH, *Commissioner of Patents.*

Cleveland, December 29, 1842.

DEAR SIR—Yours of the 21st is just received. In answer to your first query, viz., How much lard will a hog make weighing 300 lbs., very fat, after taking out the hams and shoulders?

I would state that there is a great difference in hogs as to their frame and the kind of food they have been fatted upon. The average Ohio hogs (common breeds) will produce, when tried by steam, 50 per centum lard, after deducting the hams and shoulders. The plan now generally adopted is, not to take out the shoulders; the sale for them is limited, and price low; the covering of fat will produce more in lard than the expense of curing would warrant. The mixture of the China and Berkshires, fed upon potatoes or any other vegetable containing starch as a principal food, would produce, when very fat, at least 70 per centum, after taking out *only* the hams.

The steam apparatus is merely a tub with a false bottom, perforated with holes, lying about two inches above the bottom. The steam is introduced between the two bottoms, and so entirely separates the fat from the cells in which it is enclosed, that no pressing of scraps is necessary. The bones, lean, and scraps are left on the false bottom, and the lard floats on the surface. With steam, at a pressure of 5 lbs. to the inch, it will require from 18 to 20 hours to try off a tubful of any given quantity, steam in proportion, of course; 60 lbs. pressure would do it in one third the time. The great advantage of steam is, the whole of the lard or tallow is produced, and there is no danger of burning either.

The quality of the lard is good, but not equal to leaf lard or suet; the carcass fat does not contain as much of the concrete principle (stearin). Whole hog lard cannot be refined and made hard without a portion of the oil is extracted. I take from 20 to 40 per centum of the oil; then the balance goes through several washings in pure *rain water* by steam, after which it is refined lard. The expense is not more than one quarter of a cent per pound, but it is of more value to us than common lard, as we have a great deal of trouble and expense with it; and in only extracting a portion of the oil, we would lose by it, did it not command a better price in the market, which it should from its purity.

I cannot give you any information about the quantity of tallow from beeves, as none have been slaughtered in this section for tallow; they (beeves) must also vary very much in the amount produced, depending upon their feed, &c. The bones are worth at least half a cent per pound to calcine. From them ivory black is made (worth 2½ cents per pound), by charring them in close iron vessels.

I used to decompose the lard in acid and neutral salts. When the affinity between the parts is destroyed, I separate them by means of canvass bags placed in powerful screw presses. If I wish to make candles of the residue, the pressure is continued until all the oil, by this means, is forced out. The contents of the bags are then subjected to the action of a powerful hydraulic press, and the stearin pressed to dryness.

To produce the winter oil, we have to expose the decomposed lard to the cold, in the same manner that the crude sperm oil is exposed to produce the winter-strained oil. Upon analysis, it is found that lard oil contains 79 2.10 carbon, and pure sperm oil 79 5.10, making three tenths of one per centum difference; the other equivalent of hydrogen and oxygen are the same, excepting the difference of the three tenths. For all uses (except painting) lard oil has no equal. It burns with a strong white light, and is entirely free from either smoke or smell. It does not contain any gelatin, which makes it a preferable article for all kinds of machinery; for wool it answers better than the olive oil, which it has superseded entirely. The oil of tallow is also well adapted for machinery; for burning it is not preferable to other oil, on account of its odour. Tallow only contains about 28 per centum of oil, whereas lard contains, on the average, 62. The stearin of both lard and tallow makes a better and harder candle than sperm, and the same amount in weight produces a great deal more light.

Since you were here, the works of this company have been increased, and are now running 2000 pounds per day. Lard is coming in freely; we are paying five cents cash

per pound. The oil sells readily at seventy-five cents by the cask, and one dollar at retail per gallon, in competition with some oil from Cincinnati, which is offered at 33⅓ per centum lower.

My process is so entirely different, and the ingredients I use are so effective, that I find no difficulty in purifying the oil and lard after it is manufactured, and in producing a superior article to any other.

Yours respectfully,

J. R. Stafford, *Agent Cleveland Lard Oil and Candle Co.*

Hon. H. L. Ellsworth.

Mode of manufacturing Elain and Stearin from Lard, &c., patented by John H. Smith, No. 122 Front-street, New-York City.

To all whom it may concern.—Be it known that I, John H. Smith, of the city of Brooklyn, in the county of Kings, and State of New-York, have invented a new and useful improvement in the manner of separating from each other the elain and stearin which are contained in lard; by means of which improved process the operation is much facilitated, and the products are obtained in a high degree of purity; and I do hereby declare that the following is a full and exact description thereof:

The first process to be performed upon the lard is that of boiling, which may be effected either by direct application of fire to the kettle, or by means of steam; when the latter is employed, I cause a steam tube to descend from a steam boiler into the vessel containing the lard; this tube may descend to the bottom of the vessel, and be coiled round on said bottom, so as to present a large heating surface to the lard, provision being made for carrying off the water and waste steam, in a manner well known; but I usually perforate this tube with numerous small holes along the whole of that portion of it which is submersed below the lard, thus allowing the whole of the steam to pass into and through the lard. To operate with advantage, the vessel in which the boiling is effected should be of considerable capacity, holding say from ten to a hundred barrels. The length of time required for boiling will vary much, according to the quality of the lard; that which is fresh may not require to be boiled for more than four or five hours, while that which has been long kept may require twelve hours; it is of great importanee to the perfecting of the separation of the stearin and elain, that the boiling should be continued for a considerable period, as above indicated.

My most important improvement in the within-described process consists in the employment of alcohol, which I mix with the lard in the kettle or boiler at the commencement of the operation. When the lard has become sufficiently fluid, I gradually pour, and stir into it, about one gallon of alcohol to every eighty gallons of lard, taking care to incorporate the two as intimately as possible; and this has the effect of causing a very perfect separation of the stearin and elain from each other by the spontaneous granulation of the former, which takes place when the boiled lard is allowed to cool in a state of rest.

I sometimes combine camphor with the alcohol, dissolving about one fourth of a pound in each gallon of alcohol, which not only gives an agreeable odour to the products, but appears to co-operate with the alcohol to effect the object in view; the camphor, however, is not an essential ingredient, and may be omitted. Spirit of lower proof than alcohol may be used, but not with equal benefit.

After the boiling of the lard, with the alcohol, has been continued for a sufficient length of time, the fire is withdrawn, or the supply of steam cut off, and the mass is allowed to cool sufficiently to admit of its being laded, or drawn off, into hogsheads, or other suitable coolers, where it is to be left at perfect rest until it has cooled down, and acquired the ordinary temperature of the atmosphere; as the cooling proceeds, the granulation consequent upon the separation of the stearin and elain will take place and become perfect. The material is then to be put into bags, and pressed moderately, under a press of any suitable kind, which will cause the elain to flow out in a great state of purity, there not being contained within it any appreciable portion of the stearin; this pressure is to be continued until the stearin is as dry as it can be made in this way.

The masses of the solid material thus obtained are to be remelted, and in this state to be poured into boxes or pans, of a capacity of ten or twelve gallons, and allowed to form lumps, which I denominate blocks; these, when removed from the vessels, are piled or stacked up for a week or ten days, more or less; the room containing it should be at a temperature of nearly eighty, which will cause a sweating or oozing from the blocks, and they will improve in quality; the blocks are then to be rolled in clothes or put into bags, and these placed between plates and submitted to very heavy pressure by means of a hydraulic press. After this pressure it is brought again into the form of blocks, and these are to be cut up by means of revolving or other knives or cutters. The pieces thus obtained are to be put into bags, and subjected to the action of hot water or steam, in a press, until it becomes hard enough to be manufactured into candles, or put up for other purposes to which it may be desired to apply it.

The manner of subjecting it to the action of heated water or of steam, is to place the bags containing the stearin in a box or chest, into which heated water or steam may be introduced, but not to such extent as to fuse the stearin. A follower is then to be forced against the bags contained in the box or chest, and moderate pressure made upon them; the material will now be found to have acquired all the required hardness, and to possess a wax-like consistence, such as would generally cause it to be mistaken for wax.

I am aware that alcohol has been used for the purpose of separating elain and stearin from each other in analytical chemistry; but the lard, or other fatty matter consisting of these substances, has, in this case, been dissolved in the heated alcohol, and the whole has been suffered to cool together; this process would be altogether inapplicable to manufacturing purposes, as the cost would exceed the value of the product. In my manufacturing process, instead of dissolving the lard in alcohol, I add a small proportionate quantity of the latter to the former, the whole of which is driven off at an early period of the ebullition, but by its presence, or catalytically, disposes the elain or stearin to separate from each other, which they do after long boiling and subsequent cooling. I do not, therefore, claim the use of alcohol in separating elain and stearin from each other, by dissolving the fatty matter in heated alcohol, and by subsequently cooling the solution; but what I do claim as my invention, and wish to secure by letters patent, is the within-described method of promoting their separation, or by incorporating alcohol, or highly-rectified spirits, with the lard in small proportionate quantities, say one gallon, more or less, of such alcohol or spirit, to eighty gallons of lard, and then boiling the mixture for several hours, by which boiling the whole of the alcohol will be driven off, but will have left the elain and stearin with a disposition to separate from each other, on subsequent cooling, as herein described and made known.

JOHN H. SMITH.

Witness, { T. H. PATTERSON,
H. S. FITCH.]

SUBSECT. 3.—*Vegetable Oils used for Light.*

596. On the Continent lamps are chiefly supplied with these; and since sperm oil has become so dear with us, they are much employed here. Some of these are cheaper than the fish oils, but require the consumption of a greater quantity to give the same light.

597. *Olive oil* is too costly in Britain to be generally used in lamps; but in France and Italy, where it is much cheaper, it is extensively employed in this way. It burns with a beautiful white light equal to wax, is not apt to clog the wick, and gives no offensive smell in burning. (See a more particular description of olive oil in Book VII., "On Food," Sect. 10, Chapter VII.)

598. *Rape oil* is made from the seeds of *Brassica napus*, Linn., chiefly in Flanders. The oil is expressed by a mill constructed on purpose. It has a yellow colour, and a peculiar smell. It is much used on the Continent.

599. *The oil of tobacco seeds and of belladonna seeds* are perfectly mild, and are burned in lamps in Germany, though the oil cakes of both are poisonous.

600. *Oil of plum stones* is used at Wirtemberg for lamps.

601. *Colza oil.* In France and the Netherlands they extract from the seeds of a species of cabbage, *Brassica arvensis oliefera*, an oil called *colza*, which they use in lamps, or for the fabrication of soft soap. The seed is beaten out like grain, and the oil is procured by pressure; but to prepare it for burning it is purified, or deprived of its mucilage and colouring matter. To effect this, two parts of concentrated sulphuric acid are mixed with 100 parts of oil, and well stirred until the acid combines with the mucilage and colouring matter, which are gradually precipitated in flakes of a blackish-green colour; after which, in order to separate the acid, a quantity of water equal to double that of the oil is added; the whole is agitated, and left to settle for ten days, at the end of which time the oil which is upon the water is decanted into tubs, in the bottom of which are holes filled with cotton, through which the oil filters in a purified state. The same method of purification is applicable to all oils expressed from seeds. The oil of colza is of a pale yellow colour, has very little odour, and an agreeable, sweetish taste. It is analogous to rape oil, but superior.

602. *Cocoanut oil.* This oil is extracted from the fruit of the *Cocos nucifera.* When it was first imported into this country from America, it was of very limited utility, since it was not sufficiently fluid in our climate to burn in lamps, except in those of a particular construction. A piece of metal which was heated by the flame communicated with oil, and thus kept it fluid; but this was an inelegant contrivance, and the oil did not come much into use. The lamp used for burning is described in Section 14, Chapter IV. Lately, the discoveries of Chevreuil and Bracconot have been applied to this substance; and it has been separated into its stearin and elain, the former being employed in the manufacture of candles, while the elain is used for other purposes. (See "Cocoanut Candles.")

603. *Palm oil.* This is a vegetable oil which is solid in the usual temperature of this

climate, and is now extensively imported from Africa, and employed in the manufacture of candles and soap. The stately palm-tree from which it is obtained, the *Cocos butyracea*, grows abundantly on the coast of Africa and Brazil. The fruit consists of a thick-shelled stone of a dark colour, covered by a succulent pulp, and it grows in clusters at the base of the leaves. It affords two kinds of oil; one of which is yellow, obtained from the pulp by expression; the other, a white oil, procured in a similar manner from the kernel within the stone. It is the yellow oil which has been chiefly brought here. It is had in immense quantities in Guinea and Sierra Leone. In its natural state in that climate it is always fluid, and the negroes use it to eat with their rice, or to fry fish in; and it seems to be as important to them as butter to us, or as olive oil in Italy. It melts at 84°. The white oil is in smaller quantity, and is always solid, even in Africa. The negroes employ it to oil their skins with, and it preserves them nice and soft; while, at the same time, it prevents too great an excretion of perspirable matter. The kernel of the fruit is of an agreeable flavour when eaten.

Stearin is likewise procured from this palm oil for candles by the following process: The thick oil, called "butter of palm," is kept for two hours, with the addition of a little water, in a Papin's digester, having the valve loaded with the pressure of two or three atmospheres. After this process it is subjected to a hydraulic press, which forces out the elain or fluid oil, leaving the stearin behind. Both products are then bleached to deprive them of their yellow colour. Stearin is likewise procured from the oil that is extracted from the kernels.

In the account of a late voyage up the River Niger in Africa, we are informed that palm oil is produced in immense quantities by the negroes about the town of Eboa, and is collected in small gourds, from which it is emptied into puncheons; and that it may be purchased there for about four shillings per ton. In 1808, the import did not exceed one or two hundred tons per annum: it is now nearly 14,000 tons, having been trebled in the last eight years. The increase in the quantity of palm oil procured by the negroes for exportation proves their industrious dispositions.

604. *Vegetable wax.* A species of wax exists ready formed in many vegetables. The varnish on the leaves of some trees consists of it, as also that on the skins of plums and other fruits. It is found likewise in the juices of many trees, which yield it so abundantly that wax is thus collected and employed for making candles.

605. *Myrtle-berry wax* is a vegetable substance, intermediate between wax and fixed oil, which becomes concrete at the ordinary temperature of this climate, and is used for making candles in Louisiana, and other parts of North America. It is the produce of the *Myrica cerifera*, known familiarly by the name of the *candle-berry myrtle*. The tree grows to the height of from four to twelve or eighteen feet, being tallest in the warmer regions: it has a considerable resemblance to the common myrtle. The seeds, which are of the size of a pepper-corn, grow in large bunches, and are coated with wax that approaches to the nature of bees' wax, though a distinct substance. The fruit ripens in November or December; and being stripped from the branches, it is thrown into large iron pots containing water, which is boiled as long as any waxy matter continues to rise. The melted wax, or vegetable tallow, is then skimmed off, and is remelted and clarified. Its appearance, when cold, is much like that of bees' wax; but its colour is a dirty green. When formed into candles, it is generally mixed with about one fourth of its weight of tallow. It gives a clear and steady light, nearly equal to wax candles: it never gutters, and, while it is burning, produces an extremely pleasant balsamic odour. This substance is prepared for commerce along the Canadian lakes. One of the best of these shrubs will yield near seven pounds of berries; and four pounds of these will produce one pound of wax. The candles are dearer than tallow, but cheaper than wax. They can be bleached quite white by chlorine, and an agreeable soap is also made from the wax.

606. *The Piney*, or *tallow-tree of India and China* (*Croton sebiferum*), has supplied for ages the inhabitants of these countries with a material for candles. The tree much resembles the pear-tree; and it is the fruit that affords a combustible substance, which partakes of the nature of wax and of oil, and, from its appearance, may not be inaptly termed a tallow. The method of preparing this material is simply to boil the fruit in water, when the tallow is soon found to rise to the surface in a melted state, and on cooling forms a solid cake. Thus obtained, the piney tallow (piney is the native name of the tree that produces it) is generally white, sometimes yellow, greasy to the touch, with some degree of waxiness, almost tasteless, and has a rather agreeable odour. It melts at a temperature of 97½°, and, consequently, remains solid in the climate of India, in which respect it differs from palm or cocoanut oil. Wrapped up in folds of blotting paper, and submitted to strong pressure, scarcely any oil or elain is expressed to imbue the inmost fold. Its tenacity and solidity are such, that when cast in a rounded form of nine pounds' weight, the force of two strong men was not sufficient to cut it asunder with a fine iron wire; and even with a saw, there was considerable difficulty in effecting a division. When manufactured into candles, it comes with facility from the moulds, thus differing from wax, which does not readily admit of being cast. It gives as bright

a light as tallow, and has an advantage over that material in being free from unpleasant smell, and in not emitting a disagreeable odour when extinguished. It unites in all proportions with wax, spermaceti, and with tallow, and forms compounds with the two former, intermediate in their melting points.

It may be imported into this country at less than one fourth the price of wax; and, although it does not possess all the advantages of that substance, it is considerably superior to animal tallow. It is in use only in the town of Mangalore (province of Canara), and is there employed medicinally as an external application for bruises and rheumatic pains; and likewise, when melted with the resin of the same tree, it is used as a substitute for tar in paying the bottoms of boats.

607. *A light green vegetable wax* is common on the Malabar coast, which is easily blanched, and gives a beautiful light; and it is thought it might be imported with advantage.

608. *A mineral wax*, called *ozocerite*, found at the foot of the Carpathian mountains, is stated to be used in Moldavia for making candles; but it is inferior to bees' wax, and is of a brown colour, but may be bleached.

609. *The turpentine of fir-trees* is used for burning in lamps in countries where it is plentiful, and where the people are unacquainted with the manufacture of candles, as is the case in the Landes in the south of France; but it gives a great deal of smoke.

610. *The essential oil of turpentine* gives, also, too much smoke and smell to be used in lamps by itself, and is likewise too inflammable and volatile; but *a mixture of turpentine and alcohol* gives a dense and brilliant light, although alcohol by itself yields a feeble flame. This mixture has likewise been used for lamps under teakettles and tea-urns, with incombustible wicks of asbestos, or fine wire, or cotton; it is cheaper than spirit of wine alone, and gives no stains; but it is not altogether free from smell.

611. *Large splinters of resinous wood* are used in many countries, and have been used, no doubt, from the earliest periods, among the lower classes, instead of candles. This is frequently done in Ireland, where, in the bogs, large quantities of pine are found deeply buried, and which have lain there for many ages: when dug up, these are rended like laths, and dried, when they burn readily, giving a good deal of flame and light, and are used in their dwellings by multitudes of the peasantry, particularly in the province of Ulster. Similar slips of resinous wood are used also in North America, and in the Highlands of Scotland.

Sect. VI.—Bituminous substances used for light.

612. *Bitumen is a very inflammable substance*, and is extensively employed in some countries for procuring light by burning it in lamps. It is a natural substance found in two states, *petroleum* and *naphtha*. These issue from the earth in springs, and are collected in wells. *Petroleum* is blackish brown, about the consistence of common tar, and has a strong, disagreeable odour. Naphtha, when pure, is colourless, and thin as water, but having the same bituminous odour as petroleum. It is more rare than petroleum; and the latter is supposed to proceed from the naphtha having imbibed oxygen from the air. Pure naphtha consists of only hydrogen and carbon, without any oxygen; but the latter element is one of the constituents of petroleum. *Naphtha* is highly volatile and inflammable; it may be procured from petroleum by distillation, and appears to have the same relation to it as the essential oil of turpentine has to the crude turpentine as it comes from the tree. Both these fluids are found in vast abundance in Persia and the Birman Empire, where they are the only substances burned in lamps for light. They are likewise met with in some parts of Italy, and are employed for this purpose in the city of Genoa, Modena, &c. The wells of petroleum in the Birman Empire are said to yield 400,000 hogsheads annually. Naphtha affords a bright white flame, but the bituminous odour is unpleasant.

613. *Lately a liquid has been procured by distillation from coal tar, having most of the properties of naphtha*, and which is, indeed, nearly identical with that substance: it is employed as the solvent of caoutchouc, and it is likewise used for burning in a peculiar lamp; but it has a disagreeable, bituminous odour. This coal naphtha must not be confounded with the true naphtha mentioned above.

Another substance is frequently sold under the name of naphtha, which is procured by the distillation of wood, in the process of making acetic acid or wood vinegar, and is known to chemists by the name of *pyroligneous ether*, and sometimes by that of *pyroxilic spirit*. It is highly inflammable, more volatile than spirits of wine, and burns very well in a spirit lamp: being cheaper than spirits of wine, it is sometimes used instead of it for lamps; but what is advertised as naphtha, at 7*s*. 6*d*. a gallon, is said to be a mixture of this with oil of turpentine. It affords a flame clear and brilliant, and has the advantage of not giving any smoke, nor causing greasy stains by dropping.

CHAPTER III.

CANDLES.

614. Candles, from their portability and other qualities, supply, upon the whole, the most convenient and the most general mode of obtaining artificial light for domestic purposes. Until lately, two substances only, wax and tallow, were known as materials for candles; spermaceti was next introduced, and, at present, various substances, as stearin, &c., are added.

Sect. I.—wax candles.

615. *The making of wax candles is seldom attempted in domestic economy in this country. There are three methods of making them:* 1. By hand; 2. by the ladle; and, 3. by drawing.

616. *In the first method,* the wax is first softened and worked well by hand in a kettle of warm water; it is then taken out in pieces, and gradually, bit by bit, disposed round a cotton wick slightly twisted, which is hung upon a hook in the wall, beginning at the bottom, and proceeding to the upper part. To prevent the wax from adhering to the hands, they are rubbed over with olive oil or lard. When the candles have acquired a sufficient size, they are made perfectly round and smooth by rolling them upon a table of hard wood, with a board made of box, that is kept constantly moistened with hot water, to prevent the adhesion of the wax. This method is employed in domestic establishments in warm climates, where people often make their own candles.

617. *In making wax candles by the ladle,* the wicks are suspended from a short rod, or a circle of iron over a tinned copper vessel, containing melted wax; a large ladleful of this is poured gently and repeatedly on the tops of the wicks, till the candles have acquired a proper size: they are then rounded and smoothed by rolling on a table as before mentioned.

618. *The third method, by drawing,* is usually employed when candles are manufactured upon a great scale. The wicks, in great lengths, are made to go through a vessel of wax kept melted, and as they come out of the wax, they pass through holes in a plate of metal in the way that wire is drawn, only instead of passing them through holes each one smaller than the other, they are passed through holes successively larger, the candles increasing in size by being drawn again and again through the melted wax. These long cylinders are afterward cut into the proper length for candles.

619. *In France* the wax candle is termed *bougie,* to distinguish it from the tallow candle, called *chandelle.* Spermaceti candles are *bougies diaphanes.* The best wax candles are made at Le Mans, and have hence been named *Bougies de Mans.*

620. *Wax tapers* are of two kinds. The first are larger than a candle, and used in church solemnities, funeral processions, &c. The use of lights in religious ceremonies is of long standing. The ancients used them in their sacrifices; and they were introduced into Christian churches probably from the necessity of procuring artificial light where the windows were very small, and before glass came into general use. They are still much employed in Roman Catholic churches. The wicks of tapers are made of half cotton and half flax, and the wax is poured on them by a ladle, repeatedly, until they have acquired sufficient thickness. They are then rolled, while a little soft, upon a smooth table. Small *wax tapers* are drawn in the same manner as wax candles, and afterward made up into coils, for various domestic purposes.

Sect. II.—spermaceti candles.

21. *Spermaceti candles are of modern manufacture.* The nature of the substance has been already described. They nearly resemble those of wax in their qualities: they are smooth, with a fine gloss, almost semi-transparent, and of a silvery white, while those of wax have always a slight tint of yellow. When genuine, drops of spermaceti leave no stain. They are cheaper than the best wax.

Sect. III.—tallow candles.

For the nature of tallow, see Sect. 4, Chap. II.

622. *Tallow candles are of two kinds:* the one dipped, the other moulded. The manufacture of these is very different, excepting what relates to the melting of the tallow, and making the wick, which is nearly the same in both. The wicks are made of spun cotton, loosely twisted, and prepared in large balls. The manufacturer puts three or four or more threads together, according to the intended size of the wick, and cuts them off to the proposed length of the candle.

Subsect. 1.—*Dipped Candles.*

623. *In making dipped candles,* the cotton wick is pulled, made straight and smooth, and

Fig. 99.

freed from all knots and imperfections; then put on the broaches, *a b*, *fig.* 99, which are rods about half an inch in diameter, and about three feet long. The different kinds of tallow being weighed and mixed in their due proportion, are cut or hacked into pieces, and, to be melted, are thrown into a pot or boiler, having a cavity of some depth running round the top, to prevent the accident of its boiling over, which would be dangerous from its catching fire. Being melted and skimmed, a certain quantity of water is thrown in, proportioned to that of the tallow, for the purpose of precipitating to the bottom the impurities that escaped the skimmer. The tallow, however, intended for the first three dips must have no water, because water imbibed by the dry wick would make the candles spit and crackle in the burning. The tallow, thus prepared, may be used after it has stood three hours. It is then drawn off through a sieve into a vat or cistern, supported upon a stand, having a small fire beneath to keep it melted. The workman next takes two or three broaches with wicks, and immerses them carefully in the tallow, holding them over the vessel to drain, and hangs them on a rack till the tallow gets hard. They are then dipped a second time, hung up again; and the same a third time, repeating the operation till the candles are of the required thickness. During the process, the vat must be supplied with fresh tallow kept at the proper temperature. When the candles are finished, their peaked ends or bottoms are taken off; not with a cutting instrument, but by passing them over a flat brazen plate heated to a proper pitch by a fire underneath, which melts down as much as is requisite. In manufactories where candles are made on a large scale, they have a contrivance by which a great number of broaches are lowered at once into the tallow, and raised again. If the wicks of candles are badly made, and contain loose projecting threads, the candles will be liable to have wasters, will gutter, and the light will be variable and unsteady. Waxing the wicks is sometimes used as an improvement, and the light is thus more equal and steady: it costs a little more; the wick is thus necessarily thinner, and the candles scarcely give so good a light as the common dipped candles, if well made. They are, however, more elegant, and approach nearer to a wax candle.

SUBSECT. 2.—*Mould Candles.*

624. *Mould candles are made thus:* The moulds are cylinders of pewter, having the inside diameter the size of the candles required; and one end, that on which the candle is to be lighted, is contracted into the form of a cone, *c*, *fig.* 100, having an aperture only large enough to admit the wick. The cotton wick, properly prepared, is then passed into the mould, and a piece of stiff wire is used to assist in getting it through. The wick is doubled, and in the loop there is run a small piece of wood, *d*, which is laid across the open end of the mould. By pulling the wick tight at the conical end, it may be adjusted, so as to be placed exactly in the centre of the mould; and, still holding the wick tight, a peg is driven into the middle of it, at the conical aperture, to secure it in its place, and stop up the bottom of the mould. When the wicks are exactly adjusted, the moulds are placed in the frame *e*, and the melted tallow is poured into them, and allowed to get quite cold and hard: as the tallow gets cold, it shrinks, and leaves a hollow at the top of the mould, which requires filling up with more melted tallow. The pegs at the bottom are now taken out, and the candles are drawn from the moulds. If they do not draw readily, plunge the mould for an instant into hot water, and the candles will come out easily. Some bleach or whiten their candles, by hanging them out in the dew, or earliest rays of the sun, for eight or ten days, care being taken to screen them in the daytime from the heat, and in the night from rain, by waxed cloths. Upon the whole, many persons find it less trouble to make mould than dipped candles.

Fig. 100.

625. *Tallow candles, when well made, of good tallow, resist decomposition for a long time*, and will keep for two years. When laid up for store, they should be preserved from the atmosphere; and it is found a good practice to keep them covered up with bran. Light turns them yellow, though it whitens wax. The storeroom should be cool, and free from damp, as this mildews them, and causes them to gutter. They are better for being kept for six or eight months.

Rush-lights are made in the same way as dipped candles, only having the pith of a rush for a wick instead of cotton; they require no snuffing, as the burned wick falls off as the tallow consumes: hence they are used to burn all night in bedchambers. Very small cotton wicks will answer the purpose, and are less liable to go out, owing to the smallness of the wick causing it to bend as in a wax candle.

SECT. IV.—COMPOSITION CANDLES.

626. *Composition candles are a kind lately introduced*, and which originated chiefly in consequence of the researches made about twenty-five years ago by the French chemists, Chevreuil and Bracconot, respecting the nature of tallow and other fatty substances. Tallow was formerly regarded simply as fat, or a uniform and solid oil; but it has been shown (as we have stated already) to consist of two substances: a solid fat, which is called *stearin*, from the Greek word for suet; and a liquid fat, named *elain*, from the Greek word for oil, the former being in the largest proportion.

627. *Stearin is the chief ingredient in* suet, lard, and butter, and is the cause of their solidity; whereas oils contain a much larger proportion of elain, and hence they are fluid. These two principles may be easily separated from each other, and a simple experiment will exhibit the truth of this statement. If fat be exposed to a considerable degree of cold, and then pressed between some folds of unsized paper, the latter will absorb the elain, and the stearin will remain. Having thus collected a quantity, press the paper under water, and the elain will float on the surface as an oil. The stearin, by proper management, from its beautiful colour and consistence, was found to be a very elegant material, and better adapted for making candles than tallow. The elain is admirably suited for oiling the wheels of watches, or other delicate machinery, since it does not thicken or become rancid by exposure to the air, and requires a cold of 20° Fah. to freeze it.

But, notwithstanding the superiority of stearin to tallow for making candles, the expense of separating it by mechanical means alone was found to be too considerable.

628. *In* 1825, *M. Gay Lussac, a French chemist, took out a patent* in England for an improvement in candles from the above principle, combined with the following: When tallow is mixed with an alkali, as potash, soda, or lime, it is saponified, or made to form soaps; and when, by the action of an acid, such as the sulphuric or muriatic, these new combinations are decomposed, the fats reappear in the altered form of stearic, margaric, and oleic acids; the first being harder than tallow, and of a texture resembling spermaceti, the latter being fluid like oil.

By certain chemical management, and the action of a powerful press, Gay Lussac was enabled to separate the oleic acid from the stearic and margaric; and the two latter were found to be an admirable material for candles, which were accordingly made and known by the name of *stearin candles*, the only objection to which was their expense, though less than wax. Another advantage in these candles was, that, by making the cotton wick hollow, the current of air ascending them caused the wick to be consumed without the necessity of snuffing.

629. *To diminish the expense of the stearin candles*, other manufacturers employed lime as an alkali, instead of the potash or soda used by Gay Lussac, by which stearic acid is procured, but not in a state quite so fit for candles. Accordingly, some process to harden it had been employed by them, and candles made of stearin and certain other ingredients, with which the public was not well acquainted, had been in use for several years.

630. *Fortunately, however, of late, a discovery has been made by Mr. Everitt, that arsenic had been employed* in the manufacture of some of the candles known by the name of "composition;" and this subject has been investigated by the Medico-botanical Society. They have proved, by experiments, the highly deleterious nature of the arsenical vapours which are given off by the combustion of such candles, and put the public upon its guard against their use. Considering how generally the poisonous nature of arsenic is known, it seems difficult to imagine how any manufacturer could venture upon such a practice, the danger of which required so little chemical knowledge to perceive, were it not certain that the art of adulteration regards not the destruction of health, nor of life itself. Now that the danger of using arsenic has been so completely and publicly pointed out, it is to be hoped that no manufacturer will be so rash and unprincipled as to employ it in candles.

631. *It has also been stated by Chevreuil and others, that arsenic is not necessary* for the purpose to which it was applied, and that a small quantity of wax, and, some say, of magnesia or chalk, will answer the purpose of hardening the stearin.

632. *Candles of stearin, or, rather, stearic acid, and a small quantity of wax*, are accordingly made in London, and are found to burn nearly, if not quite, equal to wax, though considerably cheaper. They are called in the shops *stearin wax*, and also *ceratin*.

633. *Other composition* candles, some of which appear in their properties to be intermediate between wax and tallow, have received a variety of names by the different makers, all of which are evidently calculated to mislead, as *German wax, pearl wax, imperial wax, Venitian, adamantine, moulded, tropical*, &c. Of the exact composition of these it is impossible to speak with certainty, as it is kept secret by the makers. Their colour is generally an opaque white; but some have an artificial tint of pale yellow, to make them resemble wax candles. They have the advantage of burning without snuffing, and, supposing them to have no deleterious ingredient, they are useful, being about half the price of the best wax.

Sect. V.—Coccoanut candles.

634. In Subsection III. we gave an account of coccoanut oil, which is not fluid enough in our climate to burn in lamps without a particular contrivance; and it is not solid enough to be formed into candles.

635. *Advantage was taken of the discovery of Chevreuil, and a patent was taken out, in 1829, by Mr Soames, for separating the stearin from the oily principle of the coccoanut without saponification*, for the purpose of manufacturing candles. The following is the method employed: the oil is imported of the consistence of lard; is made up into pieces two feet long, three or four inches wide, and an inch and a half thick these are wrapped up, first in linen and then in sail cloth. These packages are then laid side by side, and subjected to a hydraulic press, in the temperature of about 50° or 55°, but not exceeding 60°. The oil or elain will come through the cloth, and the stearin will remain. This solid portion is now taken out of the bags in the press, and is next to be purified from the other vegetable principles with which it is usually combined, such as fibre, mucilage, &c. For this purpose it is put into a covered boiler, placed in a water bath to prevent burning. There is then added to it two per cent. by weight of sulphuric acid, diluted with six parts of water. When this is boiled, the impurities are coagulated and precipitated; and they are separated by skimming, straining, and filtering, while warm in the fluid state, and by allowing them to settle in the cold state. The substance thus obtained is of firm consistence, and form an excellent material for candles. The candles are made in moulds in the usual way. They burn with a flame nearly equal to that of wax, certainly giving more light than the same sized candles made of tallow; nor is there any disagreeable odour. They are not, however, equal to the stearin wax.

636. *The elain, or liquid coccoanut oil*, which has been pressed through, is purified by mixing with it from one to two per cent. of common sulphuric acid, and agitating it in a vessel like a barrel churn. When drawn off, it has a dirty whitish appearance; but when allowed to rest, a scum rises to the surface, which is removed, as well as a sediment which falls to the bottom, leaving the oil nearly clear, and fit for burning in ordinary lamps, and other purposes.

Sect. VI.—Palmer's candles.

637. These are altogether a very ingenious invention, not requiring to be snuffed. *The candles are made of tallow. To form them*, to a portion of the strands, about a tenth part of them, is applied a portion of bismuth in a finely divided metallic state, or else the nitrate, or any other similar preparation of bismuth. The portion of the wick thus prepared is surrounded by more strands, till it becomes half the thickness required for the wick, which is the ordinary thickness of a tallow candle. This prepared wick is then cut into lengths twice as great as that of the proposed candle. The wick is next twisted spirally round a thick steel wire, in contrary directions. A notch is made in the lower end of the wire to receive the middle of the wick, and the upper end is bent into a rectangular loop to retain the two ends of the wicks together, and to facilitate its removal, when the making of the candle is completed, which is to be effected either by moulding or dipping, in the usual manner. The consequence of this construction of the wick is, that the two halves curl over to different sides, as is seen at *a*, *fig.* 101, each half pro-

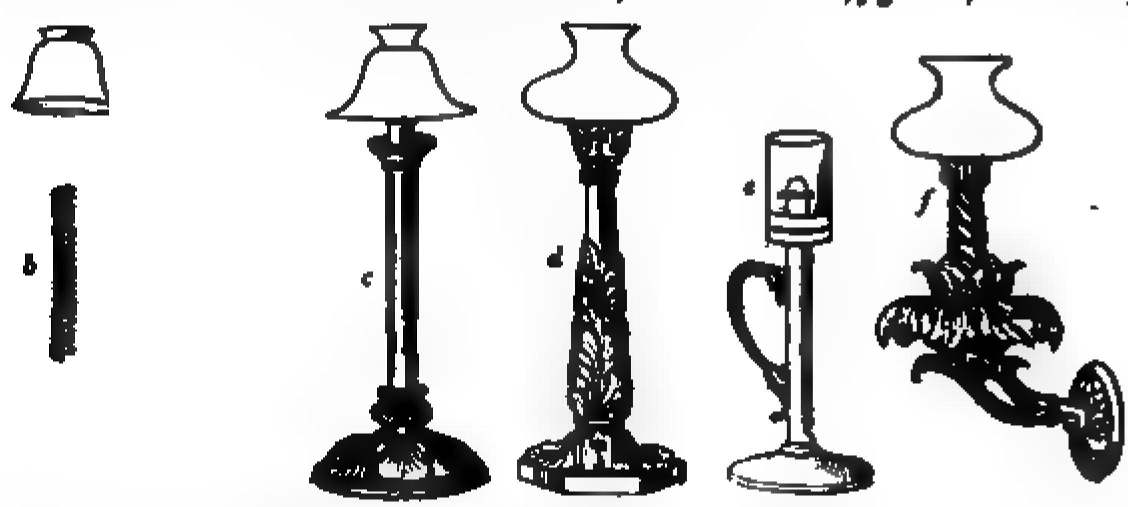


Fig. 101.

jecting out so far as to get beyond the flame, and, of course, coming into the air, by which it is consumed and reduced to ashes, while, at the same time, no carbonaceous matter settles upon it. Snuffing is, therefore, altogether unnecessary.

638. *These candles give a remarkably clear, steady light*, and always of the same brightness. From the wick being double, it gives almost the effect of two flames united, and the air having access to the centre, has the effect of consuming the smoke.

639. *It is to be observed that Palmer's patent* is for the candles just described, but not for the candlestick in which it is used: this is made by various persons. In order

that the flame may always be at the same height, the candle is pressed upward by a spiral spring *b*, in the manner of a coach lamp. In these candlesticks the spring is usually concealed in a brass tube, as at *c* and *d*, and the candle is also put into the same tube, which is the most elegant arrangement: but an inconvenience sometimes attends those; the tallow is apt to run down and clog the spring, and the servants seldom know how to clean it out. In the arrangement as at *a*, the candle being outside, this accident cannot happen; but it is much less elegant.

640. *Some add a cylindrical glass round the flame*, and over that a ground glass shade. This prevents the flickering of the flame, which is so troublesome, and conceals the light from the eye. The candlesticks are made of very elegant patterns; *e* is a candlestick of this kind adapted for carrying about; and *f* is a bracket candlestick. They are likewise made with double lights, and for suspending. This invention is, perhaps, on the whole, the most convenient and elegant apparatus we have for giving light in reading, or for lighting a small room.

641. *Mr. Palmer has also made candles of this construction, of a much larger size*, which he calls *magnum candle lamps*, *fig*. 102. These are calculated, in many cases, to supersede the table lamp, as one of them is sufficient to light a moderately-sized room. They save a great deal of trouble in trimming, and have an advantage in point of cleanliness. Of magnum candles some have four wicks, and these are said to last eight hours, giving a light equal to Argand's lamp. There are also shorter candles with three wicks, that give half the light, and last the same time. His common metallic single wicks, *e*, *fig*. 101, are eight to the pound, last eight hours, and give the light of an ordinary mould candle; with double wicks, six to the pound, *a*, *c*, and *d*, the light of two candles, and last five hours and a half. The price is eleven pence per pound. He likewise makes other varieties; and some of these candles are of stearin, which are proper for a warm atmosphere.

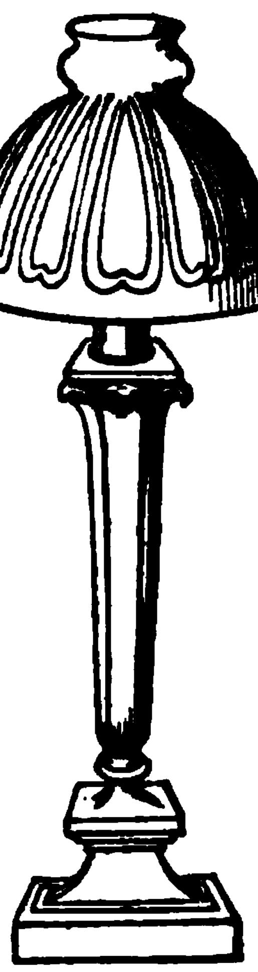


Fig. 102.

642. *The Soho candle lamp*, invented by Crosse and Blackwall, *fig*. 103, is made hollow, and a wick is contrived to move up or down through the candle, so as to make that part of the wick above the surface of the tallow higher or lower, thus increasing or lessening the consumption of tallow, and, consequently, the light. The candle is contained in a hollow stem with a spiral spring, in the same manner as Palmer's, which keeps it always at the same height; and the wick is elevated or depressed by means of a rack and pinion at the bottom, moved by the nut *a*; by bringing the wick down enough, the light can be extinguished. With candles four or two to the pound, it is said that more light is given than by the same weight of candles burned in the common way. The smoke is also destroyed by the form of the glass cylinder put over the flame; by means of the contraction of the glass at the lower part, the air is made to impinge upon the flame, and thus cause the combustion of what would otherwise escape as smoke. Besides this cylinder, there may be a ground glass moon. The Soho candle lamp is an admirable "table lamp."

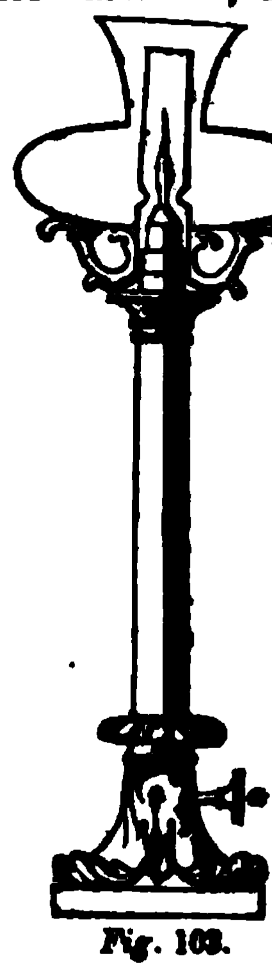


Fig. 103.

SECT. VII.—OTHER VARIETIES OF CANDLES.

643. *The Chinese have a kind of candle* about half an inch in diameter, which, in Canton, is called a "lobstock." The wick is of cotton, wrapped round a small stick or branch of the bamboo. The body of the candle is of white tallow; but the external part, to the thickness of one thirtieth of an inch, consists of waxy matter, coloured red. This covering of wax gives a considerable degree of solidity to the candle, and prevents guttering, because it is less fusible than the tallow itself, and therefore a cup is formed, which holds the melted tallow.

644. *Similar candles have been made at Munich*, with wicks of light wood, covered neatly with unspun cotton; these have been found to burn very steadily, and not to run: but they are troublesome to snuff, which must be done with sharp scissors, and they do not appear to possess advantages to counterbalance so great an inconvenience.

645. *Candles with hollow wicks* have been tried, which appear to promise the advantage of giving more light by a supply of air to the centre of the flame, in the same way as in Argand's lamp, but they are little used.

646. *Cobler's candles* are made with double wicks. It was suggested by Dr. Franklin that the flames of two candles, brought almost into contact, gave more light than when both were separate. Upon this principle, double-wicked candles give a great deal of light.

647. *Perfumed candles are made in Paris.* The tallow, purified, is run into buckets of water distilled from aromatic herbs, as lavender, thyme, rosemary, &c. The tallow and water are then beaten together, and, after forty-eight hours, they are separated by means of a water-bath, when the tallow will be found to have imbibed the perfumes. The wicks are first coated with wax and spermaceti, and a small quantity of gum Arabic; wax and alum are incorporated with the tallow before it is poured into the moulds. Effectually to prevent them from greasing the fingers in handling them, they are covered over with a varnish of glover's size, gum, and alum. Candles made in this manner are nearly equal to wax.

648. *Before the duty on candles* was repealed in 1831, tallow chandlers were obliged to take out an annual license; they were likewise subject to a variety of revenue regulations, and private persons were not allowed to make candles, which checked experiments; but at present every one may make his own candles.

649. *The flambeau* differs from the taper in having several wicks, generally four, which are covered with wax. These are first made into small tapers, which, being laid together, more wax is poured round them to unite them together. They are afterward smoothed by rolling.

650. *Torches* are also used for similar purposes, but are lights of an inferior kind. The ancient torch appears to have been formed of wooden slips, or straight branches bound together by rope, the inside being filled with flax, tow, or other fibres, impregnated with pitch, rosin, wax, oil, or other inflammable substances. Some modification of a construction of this kind is still used in different countries.

SECT. VIII. — MANAGEMENT OF CANDLES, AND COMPARISON BETWEEN THOSE OF WAX AND TALLOW.

651. *To understand this well,* it is necessary to enter rather minutely into the subject of the qualities of the several materials, and some circumstances respecting the combustion of candles. The difference between the burning of wax and tallow candles depends, in a great measure, upon the different degrees of fusibility of these two substances; tallow being fusible with less heat than wax. If we observe a candle when it is burning, we find that a cup is formed round the wick, the rim of which is owing to the wax or tallow being farther from the flame at that place than close to the wick, and therefore being less exposed to heat. This cup is filled, or nearly so, with the melted material, which is thus ready to be drawn up by the capillary attraction of the wick.

652. *A candle, therefore, though apparently very simple,* is so far curious, that it is, in fact, a kind of lamp that continually keeps melting its own combustible. If the flame should melt more than it can consume, it is evident that the melted matter would accumulate, and at last overflow the cup, which does take place in what is termed the *guttering* of the candles. Now the thinner the wick the less fluid it will draw up: and it is also evident that, the more fusible a substance, the more will be melted at the same distance from the flame. If, therefore, a wax candle and one of tallow were both made with wicks of the same size, and if the wick of the wax-light were properly proportioned to the consumption, that of the tallow-candle would not be able to draw up and consume all the melted tallow, which would exceed the melted wax, from the greater fusibility of the former.

653. *It is necessary, therefore, to make the wick of the tallow-candle thicker than that of the wax candle,* to enable it to consume a sufficiency without the cup overflowing. But we have explained, when describing flame and the burning of lamps, that a thick wick occasions a good deal of smoke, from the escape of the unburned carbon vapour in the interior of the flame. The great size of the wick has another bad effect; for, as it does not bend on one side, like the wick of a wax candle, a deposition of this unburned carbon takes place upon it as it lengthens, and, of course, projects into the hollow of the flame; and at last it becomes covered with a great quantity of soot, in a sort of fungus or mushroom form, that still farther increases the evil; a candle in this state does not give above one tenth of the light of one newly snuffed. It is necessary, therefore, to take off this accumulation, together with the upper part of the wick, now lengthened by the diminution of the tallow, which process constitutes the *snuffing* of the candle. If the progress of the candle be observed, this is easily to be understood. It burns with a bright light when it is first snuffed of a proper length, because there is very little smoke, the flame being able to consume nearly all the fluid that is drawn up; but, as the wick lengthens, more fluid is drawn up than can be consumed, and therefore a large portion escapes through the top of the flame in the form of smoke. If the wick is snuffed too short, it is not able to draw up and consume so much tallow as is melted, and therefore the latter accumulates till it almost extinguishes the light, except it be relieved by the margin of the cup breaking down, which is generally the case: then the candle immediately burns with unusual brightness. It is, therefore, of the utmost importance, in tallow candles, that the size of the wick and the thickness of the candle should be accurately proportioned to each other.

654. *The wax candle admits of a smaller wick than the tallow candle, from the less fusibility of the wax;* for a large wick is not necessary in order to consume the melted contents of the cup: but we showed, when treating on the subject of lamps, that the smaller the flame the brighter it is, there being least unconsumed vapour in the centre, and the smallest flame gives likewise the least smoke. The superiority of the wax candle, therefore, consists in this: that, from the smaller degree of fusibility of wax than of tallow, we can afford to make the wick of a wax candle thinner in proportion than that of a tallow candle, the flame being, at the same time, more brilliant. This thinness of the wick also causes it to bend of itself, till its extremity comes outside the flame, and then the part which projects is burned to ashes by its contact with the air: wax candles, therefore, require no snuffing, there being no accumulation on the wick, which is kept short by being burned as we have mentioned.

655. *The following degrees of fusibility* of different substances will point out their relative advantages. Palm oil melts at 84°; tallow at 92°; spermaceti at 133°; and wax at 155°.

656. *The goodness of candles depending upon* the inferior degree of fusibility of the material, it is obvious why the employment of too much mutton fat, or kitchen stuff, deteriorates them, independently of the bad smell of the latter; and that one of the modes of improving candles is to discover a material of the least fusibility compared to its price.

657. *The disagreeable smell of a candle or lamp carelessly blown out* is caused by the vapour of the tallow or oil rising, for a few moments, from the red-hot wick, and escaping into the air of the room unburned. The extinguisher, by fitting close on to the cup of the candle, confines this vapour, and prevents the annoying smell.

658. *Candles have a great advantage over every other kind of light, in their great portability and cleanliness;* and they are free from the great trouble of cleaning and trimming of lamps. Small oil lamps are now made very portable; but, if of the simple kind, they always give smoke and smell, except the oil is particularly pure. The solar lamp, to be afterward described, is made conveniently small. It has not been found practicable to construct the Argand lamp, so as to have no greater flame than that of a single candle, nor to burn so little oil as to be as economical. Upon the whole, therefore, for economical and ordinary domestic purposes, no other light is found so convenient as candles: well-made dipped candles give the most light in proportion to their expense, and are preferable where economy is considered: mould candles, though having a better appearance, and being less liable to run, do not give quite so good a light.

659. *The wicks of candles* are usually made of cotton, which is found to be the best material; other materials have been tried, but without producing any improvement.

Some have thought it advantageous to steep the cotton previously in lime-water, in which there has been dissolved a considerable quantity of saltpetre. They should be well dried after this before the tallow is put to them. Candles so prepared are said to afford a clearer flame, and give a more brilliant light; the combustion of the wick is so complete as to render the snuffing of them nearly superfluous; and they do not run or gutter.

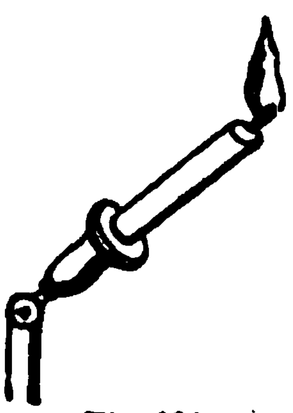


Fig. 104.

660. *If a candle be kept inclining at an angle of* 45°, *fig.* 104, it will require no snuffing, because the upper extremity of the wick, coming into contact with the atmosphere, as in the case of a wax candle, is burned to ashes. But an objection to this is, that the candle is apt to run and drop, except very well managed, and the unsightly appearance will prevent it from being adopted, except on particular occasions, when the fact may be made useful.

661. *Snuffers,* so essential a domestic implement for cleanliness and safety, in all classes of society, are, in the present day, of great variety of forms and prices. Some ancient snuffers, made of brass of very clumsy construction, have been preserved; a figure of one of which may be seen in Hone's "Every Day Book," and another in Hutchin's "History of Dorsetshire." At present, snuffers are made of brass, and of wrought iron; immense numbers are also cast immediately from the pig-metal, which, being subsequently annealed to render them softer, are filed, polished with emery, or burnished, so as to look very well; and as the cutting edge does not soon wear away, they are not ill adapted for use. The best polished snuffers are made of cast steel, which has been decarbonated, that it may bear being worked with the hammer, and thus, at the same time, retain that compactness of grain which enables steel to take so beautiful a polish. Snuffers are, in reality, a kind of scissors, constructed to cut off the excrescence which accumulates on the wick of the candle during combustion, retaining the snuff in a box or cavity. In the very cheap snuffers made of cast iron, there is no contrivance to prevent them from opening, and letting the snuff fall out; but all the best sorts have a coiled spring fixed in a cell in the shanks where the rivet is placed, to keep the box closed by the cutter when it is not in use. This spring, however, is sometimes so unpleasantly powerful as to cause the snuffers to open with difficulty, or it becomes too weak to

answer its purpose. There are many contrivances invented to obviate these inconveniences.

Hobday's patent snuffers, by the rising and falling of a steel slide or cutter, hides and retains the snuff in the box. The only objection to this ingenious method is the disagreeable snap of the machinery whenever it is used : it, however, effectually answers the intended purpose.

662. *Snuffer trays* are made of various materials. The cheapest are japanned. They are also of silver, and plated, and of papier-machée. Some are made of polished steel, having various ornaments etched upon them.

Sect. IX.—Relative quantities of light from various candles and lamps.

663. Various experiments have been made, with a view to determine *the relative quantities of light* afforded by the combustion of different materials in candles and in lamps. In these experiments economy has been chiefly considered ; but in choosing between candles and lamps, many other circumstances present themselves to our notice: such as the great portability of the former, and their small heating power, as well as the small expense and variety of candlesticks compared with that of lamps. Lamps that burn the oil with smoke are intolerable in good apartments ; and Argand's lamps, which consume their smoke, are too expensive for ordinary purposes. On the other hand, where much light is required, and portability is not an object, Argand's lamps have a decided advantage in giving no smoke ; and their light is then economical.

664. *It was observed by Count Rumford* that the relative weight of the undermentioned inflammable substances, required to produce an equal degree of light, is as follows :

A good wax candle, kept well snuffed, and burning with a clear bright flame	100
A good tallow candle, kept well snuffed, and burning with a bright flame	101
The same tallow candle, burning very dim for want of snuffing	229
Olive oil burned in an Argand's lamp	110
The same burned in a common lamp, with a clear bright flame	129
Rape oil, burned in the same manner	125
Linseed oil, burned in the same manner	120

Whale oil was not tried, as it was not to be had in Bavaria, where the count then resided.

665. *The following table gives the result of experiments made by Dr. Ure, to determine the relative intensity of the light, and the duration of several sorts of tallow candles :*

Number in a Pound.	Duration of a Candle.	Weight in Grains.	Consumption per hour in Grains.	Proportions of Light.	Economy of Light.	Candles equal to one Argand.
10 mould	5h. 9m.	682	132	12¼	68	5·7
10 dipped	4 36	672	150	13	65½	5·25
8 mould	6 31	856	132	10½	59½	6·6
6 do.	7 2½	1160	163	14½	66	5·9
4 do.	9 36	1787	186	20¼	80	2·5
Argand oil flame	. . . .	. . . . .	512	69·4	100	

Dr. Ure farther observes that a Scotch mutchkin, or one eighth of a gallon of good seal oil, weighs 6010 grs., or $13\frac{1}{16}$ oz. advoirdupois, and lasts in a bright Argand's lamp 11 hours and 44 minutes. The weight of oil it consumes per hour is equal to four times the weight of tallow in candles, 8 to the pound, and 3¼ times the weight of tallow in candles, 6 to the pound. But its light being equal to that of 5 of the tallow candles, it is a much cheaper illuminating power than tallow candles; the exact proportion will depend upon the materials at the time.

666. *It is often required to determine the relative proportions of the light* given by two illuminating bodies ; for instance, to compare the degree of light afforded by an Argand's lamp and candles ; or to compare the light of two different kinds of candles with each other. We can judge pretty well by the eye whether two lights be equal or not ; but when they are unequal, it is not possible to determine, by the eye alone, in what proportion one light is more intense than the other. Instruments, however, capable of effecting this have been invented, and these are called *photometers*. The simplest of these is that invented by Count Rumford, and which is described in the Philosophical Transactions for 1794, though one invented by Prof. Leslie is still more delicate ; but Rumford's is more simple, not requiring the purchase of any instrument ; and, by experiments of Mr. Nicholson, it has been shown that by it the degree of illumination can be easily ascertained within an 80th or 90th of the whole, a degree of accuracy sufficient for all ordinary purposes.

667. *We therefore describe the Rumford photometer* as that which is the most convenient for common use. Place the two lights that are to be compared at exactly equal heights upon two small tables or stands in a room that is darkened, and let a flat sheet of white paper, or a white cloth, be hung up at six or eight feet from the lights ; if the wall be made use of for the paper, then the lights must be six or eight feet from the wall. Take now a small cylinder of wood, or any other substance, about half an inch

in diameter (for the exact size is not material), and hold it up between the lights and the paper, and about three inches distant from the latter. It is evident that by this two shadows will fall upon the paper, occasioned by the two lights. If the lights be exactly equal, the two shadows will be of the same degree of intensity or darkness; but if one light be greater than the other, then the shadows will differ in their degree of intensity; that is, one will appear darker than the other. By moving the cylinder farther from and nearer to the paper this difference will be better perceived. It will be found that the light which is the strongest has produced the darkest shadow, and it is necessary to bring both the shadows of the same degree of shade or darkness: to effect this, move the light that casts the strongest shadow farther from the paper, and it will seem that its shadow will grow fainter, and if moved too far, it will be fainter than the other: keep moving it backward and forward until both shadows are exactly of the same colour or intensity. When both shadows are exactly equal, which will be best judged of by keeping them quite close together, measure the distances which the lights now are from the paper. Suppose, for instance, that the weakest light should be 4 feet from the paper, and it had been found necessary to remove the stronger one to 8 feet from the paper to get the shadows equal; square the two distances, that is, multiply 4 by 4, which will give 16, and 8 by 8, which will give 64: then the real intensity of the stronger light will be to that of the weaker light in the proportion of 64 to 16, or as 4 to 1. Instead of a cylinder of wood, any object held up will do; and this method of measuring two lights is so simple, that it may be practised by any person, and in any place. It may be necessary to explain the cause of the difference in the intensity of the shadows produced by two unequal lights. To understand this, it must be observed that, though we speak of a body *casting* a shadow, yet a shadow is not anything real, but merely the part that is deprived of light. If only one candle or lamp had been used, there would have been a single shadow, and that shadow would be simply the part of the paper which was deprived of the light of the luminous body which illuminated distinctly all the rest of the paper. If a more powerful luminous body should be substituted instead of this, the paper would be more strongly illuminated, and the shadow would appear darker; but this increased intensity of shadow would be the effect of the contrast between the light and the shadow, the shadow would be really the same in both cases, but would appear darker, because opposed to a stronger light. In all cases, therefore, of this kind, the stronger the light the darker the shadow will *appear* to be. This simple contrivance, which is not, in fact, an instrument, is exceedingly useful for ascertaining the comparative illuminating powers of lamps or candles. For instance, to determine how many candles any lamp may be equivalent to, place the lamp opposite to the paper at 8 feet distance, and then put candles quite close together, a little way off, but at the same distance from the paper, adding to their number till the shadows cast by them and the shadow cast by the lamp are of equal intensity, then the number of candles used will show the power of the lamp.

SECT. X.—CANDLESTICKS.

668. *Candlesticks are made in a great variety of forms*, according to the several uses for which they are wanted, or the materials of which they are composed. Those of the richest kind are of gold or silver: they are also silver plated, of brass, bronze, or other alloys, of tinware japanned, or plain; and sometimes of porcelain, and other earthenwares, or of glass.

669. *Candlesticks are no doubt as ancient as the use of candles*; and, like them, were first made for churches, in which many ancient specimens may be seen, some of extraordinary richness. It would be impossible to enumerate all the varieties of this very useful article of furniture, of which fashion is continually producing new forms, or restoring some which have been long laid aside. Of these our shops exhibit great variety, many of which have much merit. We must confine ourselves to presenting a few specimens of the principal varieties, and to pointing out some things of importance in their general construction, as far as regards utility.

670. *An inconvenience often attends the candlesticks in common use*, which is, that the same socket does not fit any sized candle; and the consequence is, that candles are generally procured rather smaller than the socket, and must be made tight by papering in some way or other, an operation troublesome and unsightly, and which becomes more inconvenient when the candle burns down near to the socket, as the paper often takes fire.

671. *To remedy this*, in appearance at least, coloured papers are used, stamped as ornaments; or cut glass is employed as an additional socket. But a superior construction is to have loose sockets, with a cylindrical plate of metal within, slit so as to form a spring that gives way to the pressure of the candle, and holds it fast without any papering. Candles are never suffered to burn quite to the socket in the best candlesticks; before they burn down so far, the pieces are taken out, and are used either in bedchamber candlesticks or other places. In ordinary candlesticks the bottoms of the sockets are made to rise up to burn the last portion of the candle. And here we may

Fig. 105.

mention a little contrivance that has just made its appearance, and is sold in the streets for a halfpenny, as a useful substitute for papering candles. *a*, *fig*. 105, is a piece of sheet brass pressed into the form represented, with a little handle bent back. This is put into the socket of the candlestick, and then the candle is pressed down. It holds the candle firmly, cannot take fire, and is easily taken out by means of the handle, after raising up the bottom of the socket; *b* shows this contrivance when in the socket.

672. *Telescopic candlesticks* are made with tubes to slide within one another in the manner of a telescope, to heighten it as the candle burns down, so as to preserve the flame at the same actual height. This construction is only used in plated or silver candlesticks, as it is expensive.

673. *Fig*. 105* *exhibits* some of the best table candlesticks now in fashion. A and B are small candlesticks. *a*, *b*, *c*, *d*, *e*, are branched candlesticks or girandoles of silver, plated, or brass gilt. *d* is a girandole of coloured porcelain and or-moulu.

Fig. 105*.

674. *Chandeliers* are suspended candlesticks, and magnificent examples are to be seen

in churches, and in large and elegant apartments. Those in churches are usually of brass or bronze, but in private houses and public rooms they are now also made of cut glass: and nothing can exceed the richness and splendour of these when ornamented,

b

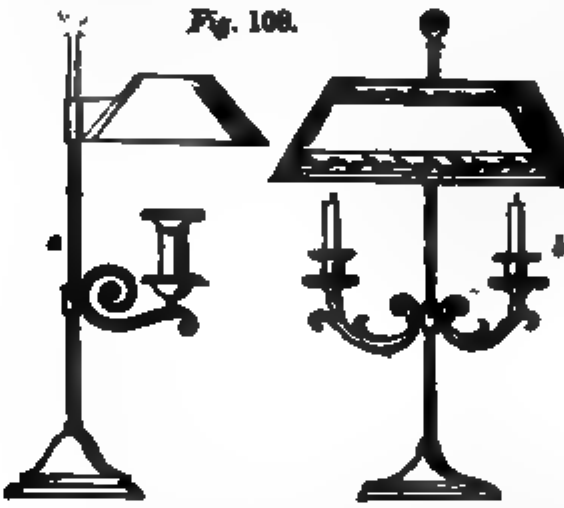
as they generally are, with a multitude of drops of cut flint-glass, which refract the light like so many gems. Instead of candles, frequently gas light is burned in chandeliers of the same forms. *c*, *fig*. 106, represents a chandelier of coloured porcelain and or-moulu; and *d*, *fig*. 107, one of brass gilt, such as are used in the best houses; the

number of lights may be varied at pleasure by altering the design a little. *b*, *fig*. 106, is a chandelier of cut glass.

675. *Lustres* are candlesticks of cut glass, ornamented with drops, and usually placed on the mantel-piece, or some other convenient place in the drawing-room. Instead of the forms, with many facets, into which these drops were formerly cut, glass, cut into the shape of triangular prisms, are now generally used, being more easily made, and refracting the light as much or more than any other shape *e*, *f*, *g*, *fig*. 107, and *c*, *fig*. 106, represent various patterns of such lustres. In *h*, *fig*. 107, the candle is concealed by a ground glass-shade.

676. *Cheap candlesticks for reading or writing* are made, with one or two candles, to rise or fall, in order to keep the light always at the same height, with conical shades to reflect the light down, and to conceal the flame from the eyes. These are not only beneficial to the eyesight, but economical, one candle giving as much light on the paper as two without shades. The shades are japanned, white within, to reflect the light strongly; *a*, *fig*. 108, may be for one candle, or, by repeating the branch on the opposite side, for two. In *b*, *fig*. 108, the shade is oval, and concentrates the light best.

Fig. 108.



677. *The best reading candlesticks* at present in use are Palmer's, and the Soho, already mentioned.

678. *Bedchamber candlesticks*, *a* and *b*, *fig*. 109, are always made low, with an extinguisher, and sometimes a pair of snuffers attached. In *b* the light is protected by a glass, which is useful in carrying *Fig*. 110 is intended for the light to be raised or lowered; and by being made to swing, it is very useful on board of ships. Japanned candlesticks for bedchambers usually have the bottom of the socket to slide up by means of a slit and a projecting piece on the side; and this permits the candle to be burned to the last bit. This construction is also generally applied to the common brass candlesticks; but in these, a wire is made to come down from the moveable bottom through the middle of the stem to the foot, so as to be invisible on the outside; and the candle is pushed up by pressing upon a knob on the end of the wire. The same construction cannot be applied to plated candlesticks, nor to those of earthenware. Bedchamber candlesticks are made of silver, brown, plated, and tin japanned; the last are remarkably cheap, and are very generally used. They exhibit a remarkable instance of what may be done in manufactures on the score of economy; a candlestick of this kind, japanned and painted, with snuffers and extinguisher complete, may be bought in the retail shops in London for 6*d*., and though not so strong nor so well finished as more expensive ones, yet is neat, and will answer very well for ordinary purposes.

Fig. 109.

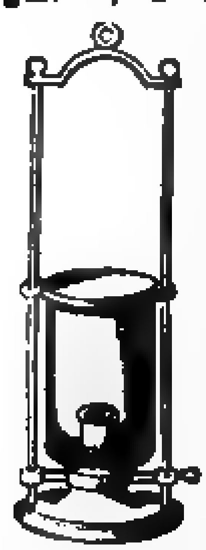


Fig. 110.

679. *Tin is the best material for kitchen candlesticks:* those which are japanned brown save some trouble in cleaning, but require much care to prevent the varnish from coming off; these should never be put near to the fire to clean, but should have the tallow melted off by hot water *Office candlesticks* are best of the latter kind; and it is very important that these and kitchen ones should always be furnished with snuffers and extinguishers, fixed to them by a piece of chain; many accidents by fire having occurred through neglect in putting candles out, when there is no extinguisher.

680 *Candlestick stands* are occasionally used to raise the candlesticks on the dining-table. They should, if possible, correspond in style to the candlesticks; and should be made heavy at the bottom.

681. *Economical housewives use*, for burning their ends of candles, a little apparatus called a *save-all*, which deserves much more patronage than it meets with. It is usually made with a socket to fit into the candlestick, on which is a circular cup, with three projecting wires to fix the piece of candle between. These wires bend, and are soon out

Fig. 111.

of order, which may be one reason why this is not a favourite; but, instead of wires, pieces of tin plate may be substituted, as in *a*, *fig*. 111, which last much longer; and also the save-all may be furnished with a handle, a construction which is very much superior. Some are made with a single-pointed wire to fix the candle upon, as in *b*; and others are made of earthenware, to imitate a candle, as in *c*, by which, when the piece is put on, it looks like a whole candle.

CHAPTER IV.

LAMPS.

SECT. I.—THE SIMPLEST KINDS OF LAMPS.

682. *The most simple lamp* consists in a vessel of any shape, filled with oil, or other inflammable liquid, and having a short depression or spout on one side, on which lies a wick composed of any fibrous substance capable of imbibing the oil by its capillary attraction. The oil thus raised and diffused through the wick, when set fire to, admits of being heated to such a degree of temperature as is capable of volatilizing the oil; the vapour of which, in a state of combustion, constituting the flame of the lamp.

683. *The wick of a lamp* serves only for the purpose of raising up the oil, and thus giving a constant supply of just the necessary quantity to the flame.

It furnishes no part of the light by the combustion of its own substance; for the quantity consumed is too small to deserve notice, and it is usually coated over with a hard deposite of carbonaceous matter, which cannot burn for want of the access of air; the flame, in fact, keeping the wick from it.

684. *Fig*. 112 *represents a lamp of the simplest kind* made of hammered iron, still used in the Orkney and Shetland islands for burning fish oil, procured by melting the livers of a small fish caught there in abundance. The wick is of peeled rush. The upper vessel holds the oil, and the lower one is to catch the drippings. The lamp is fixed in the walls of the cottages by the bent top. The Esquimaux make their lamps of a kind of pot stone, and use them not only for getting light during the long, dark, and dreary winter months, but also for boiling their kettles. Their wicks consist of moss laid in the oil.

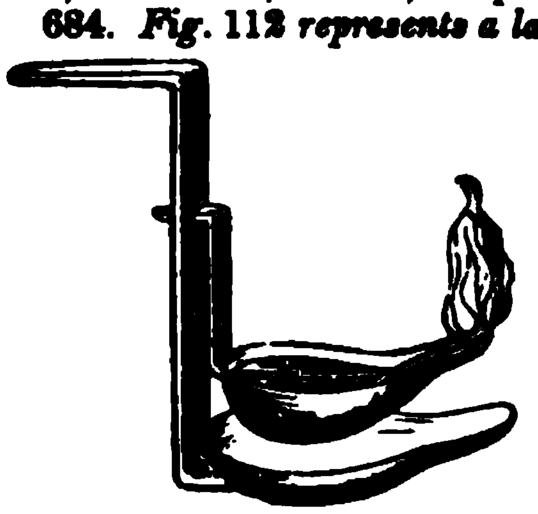


Fig. 112.

685. *Fig*. 113 *is an example of the common Greek and Roman lamp* made of terra cotta. Such are found in great numbers in Herculaneum and Pompeii.

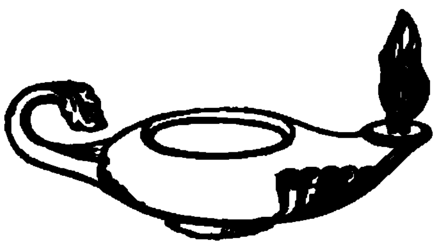


Fig. 113.

686. *Several improvements have been made in the simple lamp*. The size of the wick is a circumstance very important to attend to. We have already shown how essential it is that the air shall have access to every part of the flame, in order to ensure complete combustion: if the wick be large, a great deal of carbon vapour remains unburned in the interior of the flame, and breaks out at the top in the form of smoke; and the flame appears yellow, or even brownish. This is the case with torches, which always give a great deal of smoke. The smaller the wick, the clearer and whiter will be the flame; because, from what has just been said, it is obvious that there will be less unconsumed carbon in the interior of the flame: but a very small wick cannot give much light, as it diminishes with the superficies of the flame. The inconvenience of thick wicks has been long observed, and many attempts have been made to remove it.

687. *It was first noticed by Dr. Franklin that two small wicks, placed close together, gave more light than one equal in quantity to both*: the air being admitted between them, there is more surface of flame than in one only; see *fig*. 114, *a*. Three wicks, *b*, for the same reason, give still more light, but consume oil in proportion; but it is rather difficult to keep several wicks always at the same height, and there is a good deal of trouble in adjusting and trimming them.

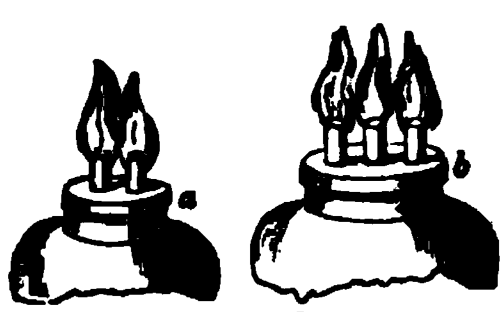


Fig. 114.

688. *A flat wick* is found to obviate this inconvenience, and to give a much better and clearer light, with less smoke, than a round one that consumes the same quantity of oil. These are, consequently, now much used.

By making the lamp of metal, and attaching an upright cylinder to the cistern, which is covered, and causing the wick to rise vertically through small tubes, greater clean-

liness is ensured: this lamp is sometimes used as a common passage lamp to hang on a wall. *Fig.* 115.

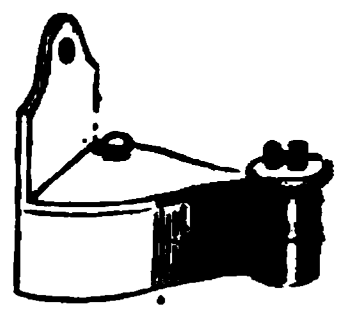


Fig. 115.

689. *a and b, fig.* 116, *represent lamps made in the form of candlesticks*, with the wick vertical. These require the wicks to be very nicely trimmed; for it is to be observed that the wick, when in this position, is more apt to contract a hard crust than when nearly horizontal. The upper part is often made and sold separate, so as to fit into any candlestick, either japanned or of brass. They form cheap lights for kitchens and other places where economy is much an object; and, indeed, if properly managed, give as good a light as small candles. *c, fig.* 116, is one of a more ornamental kind, with a glass to keep the flame steady; and, if a common cylindrical glass, with a plate, such as is afterward described, be added, these common lamps will give no smoke. These candlestick lamps require replenishing with oil pretty often, as the capillary attraction of the wick cannot raise it to any great height.

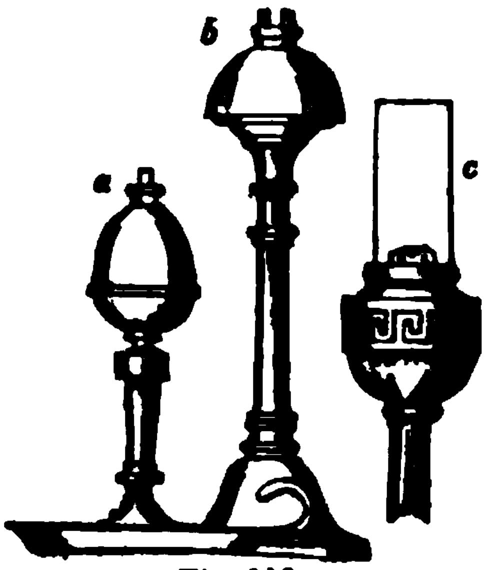


Fig. 116.

a, fig. 117, is a very economical working lamp, made for the light to be raised or lowered. The oil is contained in the conical reservoir, which slides on the stem only by the latter passing through a cork attached to the top of the reservoir.

b is also a very economical lamp, made to raise and lower, such as is used by watchmakers. The wick is made flat, and it has a shade to throw the light down, and also a cylindrical glass to keep it steady. When this is well trimmed, and the oil good, it gives very little smoke, and may be used as an excellent economical reading lamp. The oil is contained in a reservoir, and this lamp does not consume half so much as an Argand. It costs only six or seven shillings, and the addition of the oxydator, to be afterward described, completely destroys the smoke, making it thus a good and cheap reading lamp.

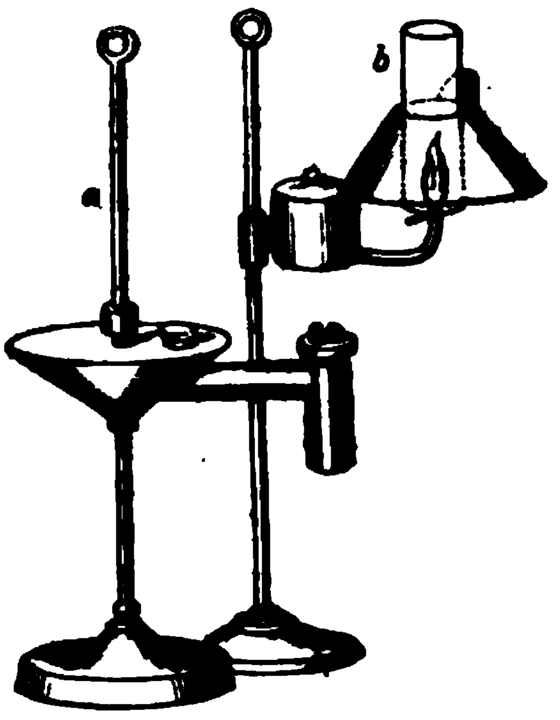
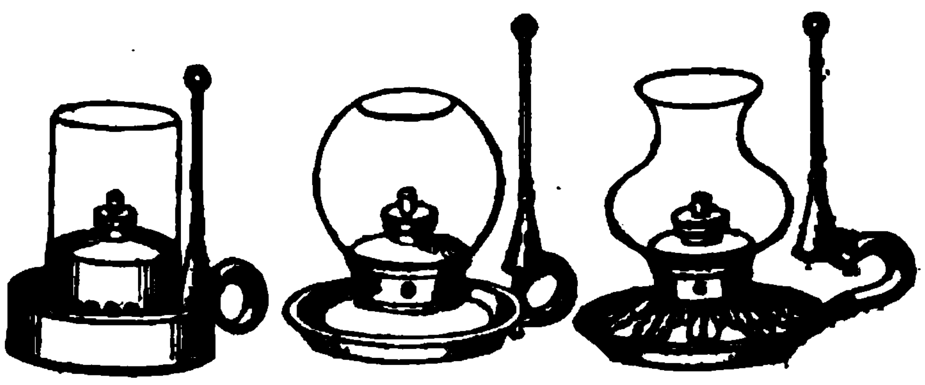


Fig. 117.

Fig. 118 exhibits small lamps made portable by a glass added to protect the flame from the wind. They are useful and safe as *bedchamber lamps:* an extinguisher is attached.

Fig. 118.



690. *Float lights, fig.* 119, are short wicks fixed into some substance that floats on oil, as a round slice of cork, or a hollow flattened sphere of glass or tin. Elegant glasses are sold for holding the oil, but any glass, as a tumbler or wine glass, will do. They are very useful for burning to give a light all night, being safe; and, by making the wick small, they may be made to give as little light as is required. The best sperm oil should be used; and it is well to put a teaspoon-full of water into the bottom of the vessel before the oil is poured in, that, when the oil is burned out, the wick may be extinguished. An inch in depth of an ordinary tumbler will burn twenty-four hours.

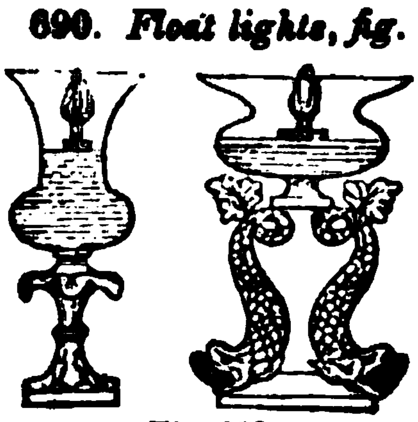


Fig. 119.

691. *Fountain lamps, fig.* 120, are those where the reservoir is above the level of the wicks, and which, consequently, burn with the same brilliancy as long as there is any oil in the reservoir.

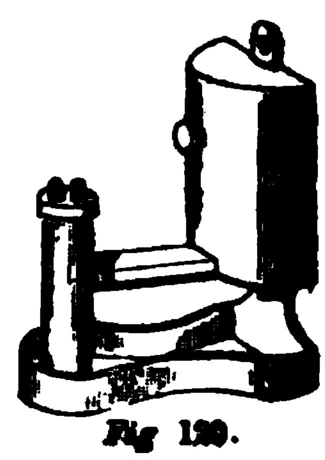


Fig. 120.

SECT. II.—ARGAND'S LAMP.

692. The smoke and disagreeable smell arising from the burning of oil in common lamps, and the unsightly appearance of the whole process, had long banished the lamp

from the apartments of the wealthy, and they had been universally superseded by candles.

693. *An invention, however, made*, 1780, *by M. Argand*, a native of Geneva, by which the smoke of lamps is entirely consumed, at the same time that the brilliancy of the light is greatly increased, even with economy, brought this instrument again into general use, and made it a successful rival to the best wax candles. The numerous advantages of the Argand lamp are not confined to affording a very brilliant and economical light, but it extends its usefulness in producing a convenient and great degree of heat for the chemist, which renders it one of the greatest improvements in the useful arts. Argand, reflecting upon the cause of the imperfect combustion in the interior of the flame of a candle or lamp, and correctly supposing that it was for want of the access of oxygen, conceived the idea of admitting air into the centre of the flame. To accomplish this, he made the wick in the form of a hollow cylinder, instead of a solid one as before; and he contrived that a current of air should pass up through this hollow cylinder where the wick was burning, thus admitting air into the middle of the flame. This was found to succeed perfectly on trial: the combustion was more complete, the smoke was diminished, and the brilliancy of the light increased. But, to improve the effect still farther, he also added a glass cylinder or chimney, open at bottom, surrounding the flame at a small distance, by which another current of air was made to pass upward on the exterior part of the flame, and between it and the glass. Thus every part of the thin circular flame is between two currents of air, which supply the combustion with oxygen so much as to create a heat that is sufficient to consume the smoke and convert it into heat and light.

This is the simple principle of the lamp invented by Argand; and it will be easily understood by examining *fig*. 121, where the dark circle in the centre of A, the place of the burner, represents the interior of the hollow cylinder through which the air ascends. The thin, dark line outside being the wick itself, and the double external line being the glass. B represents a view of the burner with the wick; and the arrows show the direction of the current of air between the wick and the glass.

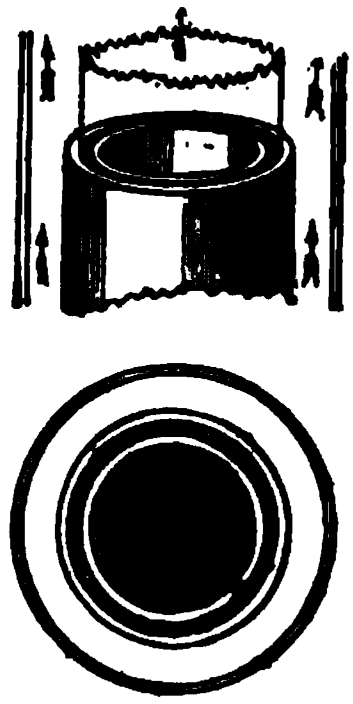


Fig. 121.

A few improvements have been made upon the original construction. The glass chimney does more than cause a current on the outside of the flame; it considerably increases that in the inside of the circular wick also: without the glass there would be a current, but it would be weak. It is of consequence to regulate the quantity of air admitted to the flame: too much air will diminish the temperature so much as to impede the desired effects, and too little will leave the combustion languid. In the common lamp the wick is fed with oil by capillary attraction, the surface of the oil being below the level of the flame; but in the Argand lamp the reservoir of oil is kept above the level of the flame.

Fig. 122 *represents the general appearance of an Argand lamp*, such as is used for reading or similar purposes. *a* is the reservoir for the oil; *b* is the cistern supplied from the reservoir, and from which the oil flows to the burner, *c*, through the branch *d*.

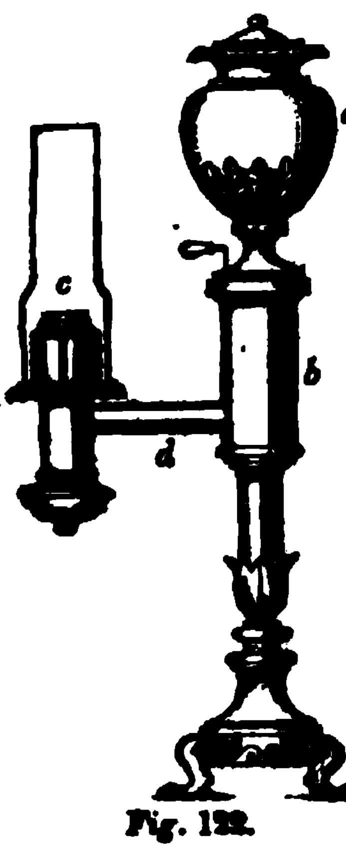


Fig. 122.

Fig. 123 is a section of the reservoir on a larger scale, together with the tubes of the burner. The vase *e*, which holds the oil, terminates below in a hollow neck, *f*, which screws into the cistern *g*. This neck has a circular hole in the side, which can be closed, when required, by a sliding piece of brass, *h*, moveable by a handle, *i*. To fill the reservoir with oil, it

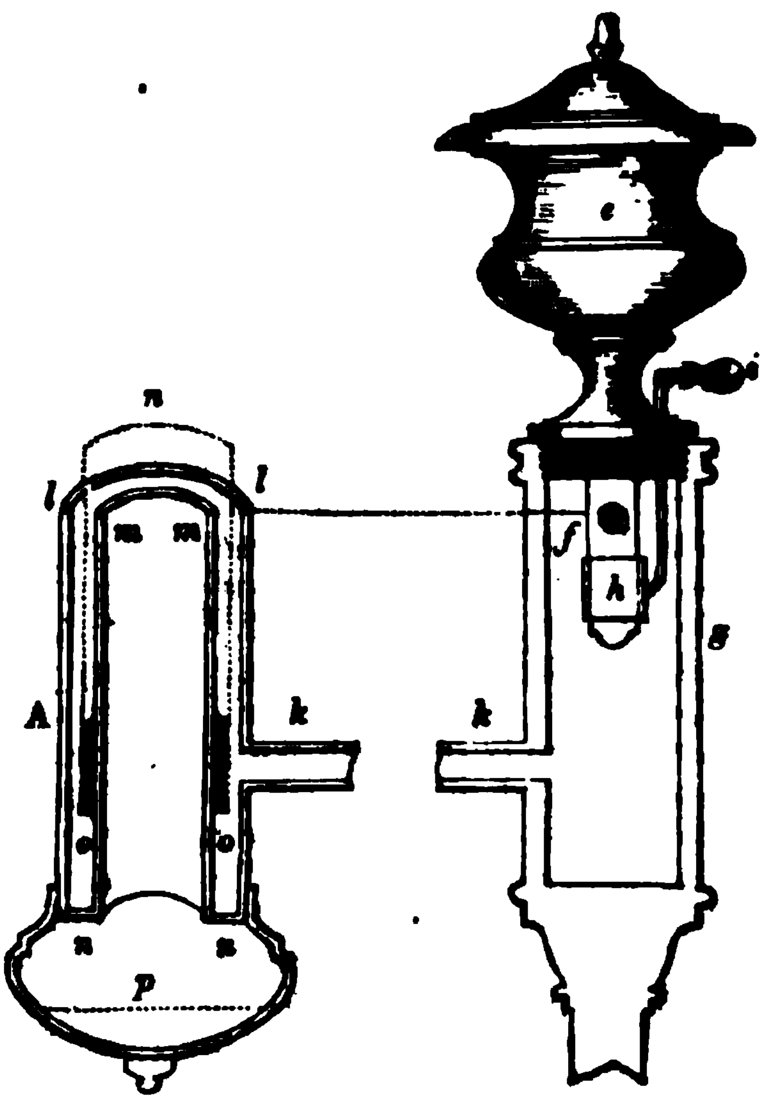


Fig. 123.

is unscrewed and laid on its side; and the oil is poured in through the circular hole in the neck. When enough oil is put in, this hole is covered by drawing up the short tube *h* over it by means of the handle *i*; the reservoir is then screwed into its place, and the hole is opened by pushing down the handle *i*; the oil then coming out through the cistern *g*, from which it passes through the branch *k*, to supply the burner. The burner part A consists of two tubes, *l l* and *m m*, one within the other, the space between to hold the oil coming from the branch *k* being closed at bottom, *n n*, but open at top. The circular wick *n*, expressed by the dotted line, is kept in the oil in this space between the two tubes by drawing it on a short cylinder of brass, *o o*, that slides upon the inner tube *m m*. At first, this wick was raised and lowered by means of a rack and pinion, but now a much neater method is employed: a spiral groove is cut on the outside of the tube *m m*, in which a pin on the inside of the short tube *o o* works, and causes it to rise or fall when it is carried round: the motion of the tube *o o* is effected in an ingenious manner by means of the shelf which carries the chimney glass. The lower portion of this burner part terminates in a cup, *p*, which receives what oil may happen to drop from the burner; and apertures are made in the upper part of the cup, by which air can have access to the inside of the inner tube, and, consequently, to that of the wick and flame. There are likewise apertures in the shelf on which the chimney-glass stands, to supply air to the space between the glass and the flame. As the reservoir acts upon the principle of the *bird fountain*, the height of the oil in the cistern must always be at the level of the wick, which is, therefore, supplied as long as there is oil in the reservoir; and, by this means, the light is always equal.

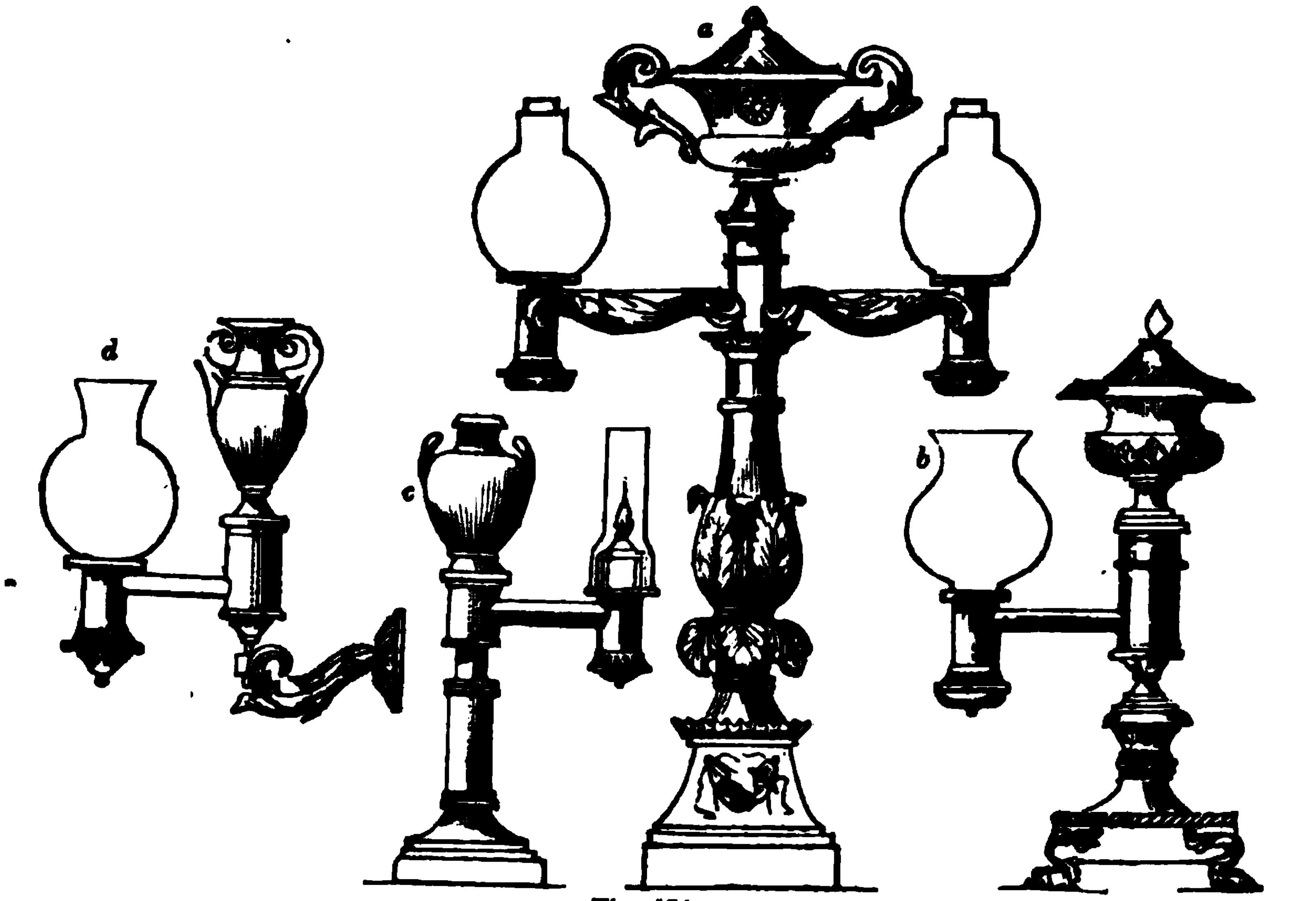


Fig. 124.

It is essential in this lamp that the flame should be at a certain distance from the reservoir of oil; otherwise the air in the upper part of the reservoir being much more expansible than the oil, it would cause the latter to flow over: this inconvenience is apt to occur in consequence of the air being expanded in a warm room.

694. *In the original construction of Argand's lamp there was an imperfection in the glass chimney*, which has been removed by subsequent improvements. The glass was at first made simply cylindrical, and then the air within rose quite vertically between it and the flame, striking upon it imperfectly; on which account the lamps could burn only the best oil. But by a French alteration of the shape of the glass, made some years ago, the lamp burns with a clearer light. Instead of being of equal width throughout, it is contracted at the level of the flame, as at *c*, *fig*. 122, by which the current of ascending air is made to turn out of its course when it arrives at this shoulder, and is propelled against the top of the flame just where the smoke is beginning to part, which, in consequence, is destroyed almost entirely; and this has been still farther improved upon by the contrivance called "oxydators," and a contraction of the glasses, which will be described afterward.

695. *a*, *fig*. 124, *represents a two-light Argand's lamp for the table*. *b* is one for the side-board or similar situations. *c* is one with a telescopic or sliding stem, to raise or lower the light, which is useful in some cases, particularly for reading or writing: but such a

light should always be used with a shade to defend the eyes from the strong glare. *d* is a bracket lamp for fixing to the wall.

696. *Fig.* 125. *e is a two-light suspended Argand lamp*, of the cheapest kind. *f* is a suspended lamp of a more elegant kind, with a cut glass basin, to prevent accident from

Fig. 125.

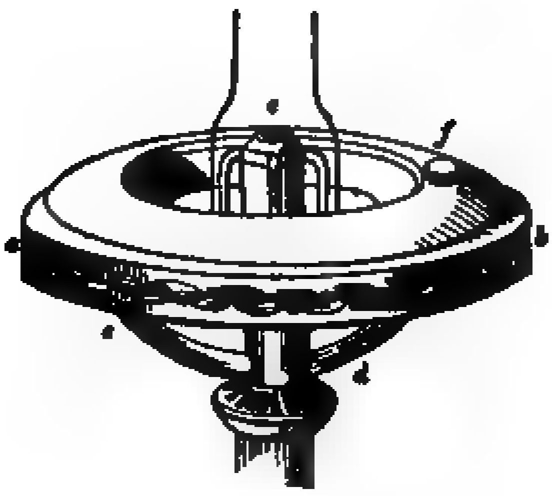
the oil dropping: it has also *moons*, or ground glass shades, over the lights. *g* is a four-light lamp with a basin of plate glass below. *h* is one of those called by the manufacturers *boat lamps*, from the arms being concealed by ornamental brass work having a slight resemblance to a boat, with three or four lights. In these lamps, although only two chains are represented, there must be three or four chains. *i* is a large lamp with the chains very ornamental, and the branches concealed by very rich brass work.

697. *Shades of ground glass* are not only agreeable in concealing the flame, and preventing the disagreeable dazzling effect of a strong light, but they appear to increase the light by dispersing it and softening the shadows. They should be cleaned once a fortnight with soap or pearlash: the latter will not injure them. For some lamps white paper, not too thick, makes an excellent shade, and particularly for an economical reading lamp. Transparent envelopes, or shades for some purposes, as lanterns for passages, may be made very elegantly of chintz of agreeable patterns; and some have cut out the flowers or other ornaments of chintz and pasted them on varnished paper. Chinese lanterns are frequently made of paper painted.

Sect. III.—Annular French lamp.

698. This lamp has been for many years very generally used in England as a *table lamp*. In the original construction of Argand's lamp, the reservoir for the oil was placed on one side of the flame; and, consequently, the light being obstructed by it, there was a strong and inconvenient shadow on that side. To obviate this imperfection, the annular lamp, *fig.* 126, has been contrived. The ring of metal, *a b*, *fig.* 126, contains the oil, which descends below the burner *c* by the tubes *d e*; a construction which is extremely simple, and, consequently, not liable to be out of order. *f* is a cap, by unscrewing which, the oil may be poured into the reservoir. The construction of the burner is on Argand's principle. This lamp was placed upon an elegant stand, as at A, and the flame was concealed by a hemisphere of ground glass; or by a complete sphere, as at B.

It is worth while observing that the French employed this construction also in lamps



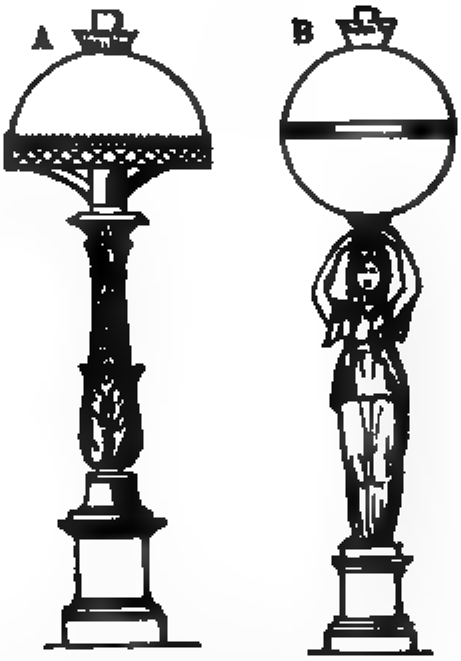


Fig. 127.

of a cheap kind for suspending, which, though not used here, yet may be useful, as they might easily be executed where Argand's lamps cannot be procured. The oil was contained in an annular reservoir of tin, japanned or painted, *g*, *fig*. 127; and, instead of Argand's burners, the wicks were of the common flat kind, but surrounded by glasses. To reflect the light down, a skeleton of wire, such as is used for bonnets, was raised over them in a hemispherical form, and on that was fixed thin silk, which being partly transparent, had a very pretty effect. Below was suspended a small glass basin to catch the droppings of oil.

SECT. IV.—PARKER'S SINUMBRA LAMP.

699. Although the object of the French lamp was to do away the shadow cast by the reservoir of the Argand lamp, this was not completely effected: for still a slight shadow was projected by the thickness of the annular reservoir, which, coming just about the level of the eyes of those at table, had an unpleasant effect. This fault was corrected by an improvement made by Mr. Parker, for which he took a patent in 1820. In his lamp, called the *Sinumbra*, or shadowless lamp, *fig*. 128, the reservoir is sloped away from the light, by reducing the breadth of the ring in front, in the manner shown in the section at *a* and *b*. The burner is on the Argand principle, with the usual glass chimney; but the form of the ground glass shade assists the dispersion of the rays of light, so as to obliterate all shadow entirely. *c* is a little metallic conical speculum fixed on the glass chimney, to reflect some rays from the flame, immediately downward. A represents this lamp complete. It is to be observed that the ground glass shade is continued below the light, as at *d* and *e*. This lamp, though obviously an improvement, is no longer made, being superseded by others to be afterward described.

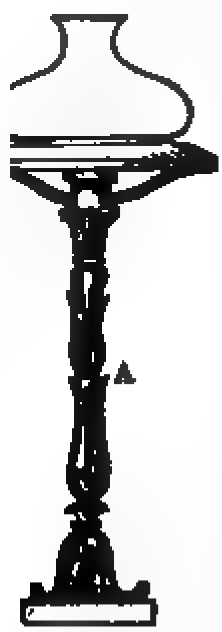


Fig. 128.

SECT. V.—QUARRELL'S SINUMBRA LAMP.

700. *Fig*. 129 is another construction for effecting the same object as Mr. Parker's. In this the bevelling or sloping of the reservoir is on the under side of the reservoir, and the ground glass distributed over the light is brought to the outside edge of the reservoir, as in the French lamp, thereby concealing it more completely. The ground glass shade, instead of being made in one piece, as in Parker's, is divided into two, one above the light, and the other, in form of a circular basin with an aperture in the middle, below the light, as *a b*. In other respects, it is like the French lamp. The little speculum, *c*, is often omitted.

Sect. VI.—ISIS LAMP.

701. The last improvement upon the French lamp appears to be what has been called by the manufacturers the *Isis lamp*, *fig*. 130, and which is now most generally

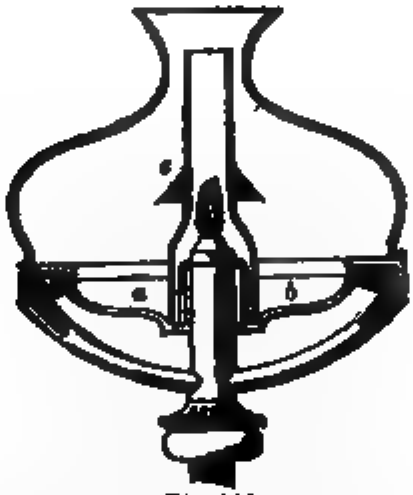


Fig. 129.

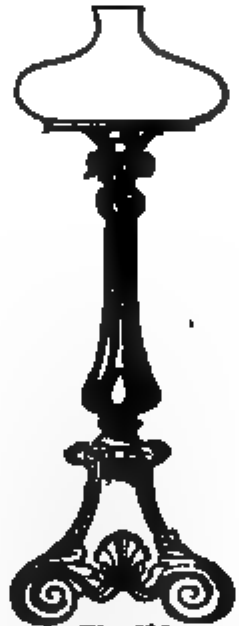


Fig. 130.

seen in the shops. In this the external appearance of the reservoir is reduced to a mere brass bead, and the ground glass distributor being brought quite to the front, no shadow is projected, and this part appears as perfect as this lamp can be. They are now frequently used as table lamps, and are manufactured in an almost infinite variety of patterns, of various prices and degrees of ornament and elegance, of brass, bronze, or part porcelain and part brass. *a*, *fig*. 131, represents a two-light table lamp; *c* is a

Fig. 131.

bracket lamp; *b* is one suspended. Parts of the stand are now frequently made of coloured porcelain, while the ornaments are of or-moulu, and brass, chased.

Sect. VII.—QUARRELL'S ALBION LAMP.

702. This is represented in *fig*. 132, A, B, C. The oil is contained in a circular reservoir like that of the French lamp; but instead of its being below the level of the flame, and to be raised by the capillary attraction of the wick, it is considerably above the flame, in the manner of a fountain lamp, as may be seen at A C, which is a view of the lamp without the glass shade and stand, and in A, which is a section of the same. B represents the lamp complete; the whole of what is exhibited in the other figures being included within the ground glass shade, and concealed by it. To fill the reservoir, the oil is poured in through the hollow two-valve cock, *b*, which at that time must have the valve, *c*, open, and the other valve, *d*, shut; there are marks on the top of the valve for setting the valves by means of the little handle, *a*. When the reservoir

B

Fig. 132.

is full, the valve, *d*, is opened, and the oil flows out of the reservoir into the descending tube, *e*, which communicates with the burner, *f*; but it passes farther on, and rises above the level of the burner, through the tube, on the opposite side, *g*, as far as *h*; compressing the air in the upper part, which, being open, is covered and surrounded by a short outer tube, *i*, one half of which is open, and communicates with the reservoir, while the other half is closed. The lamp is now ready to be lighted: when this is done, the oil begins to be consumed, and the burner is supplied by the tube *e*, which takes it from the reservoir; but no more can come from the latter, except some air enters to supply its place; and this is admitted by a very ingenious contrivance. A smaller tube, *k*, is attached to the side of the tube, *h*, and communicates with it at the lower part, the upper part being open to the atmosphere. When, therefore, the combustion of the flame draws the oil from the reservoir by the tube *e*, the atmosphere passes into the upper part of the tube *k*, and air passes downward in minute bubbles, according to the direction of the arrows, to the top, and down again through the short external tube *i*, until it arrives in the reservoir, and ascends to the upper part of it, to fill the vacuum that otherwise would be formed; and this effect proceeds as long as there is any oil in the reservoir, or until the whole is consumed by the flame One of the advantages of this lamp, therefore, is, that the supply of oil, not depending merely upon capillary attraction, as in the original French lamp, will burn with an undiminished flame as long as there is oil in the reservoir. In the French lamp the flame becomes weak some time before the oil is exhausted; and it requires more frequent supply. This lamp likewise obviates a defect which attends the Argand lamp when the flame is near the reservoir; the heat expands the air in it, and sometimes forces the oil over the burner. By the construction just described, the air which enters at *k*, and passes up the tube *h* into the reservoir, being surrounded by the oil in the latter, which is warmed by the flame, is heated to the same degree of temperature as the oil, and, in consequence, so much rarefied, that its pressure upon the surface of the fluid is considerably diminished, and therefore is not so liable to occasion an overflow at the burner. Another peculiarity belongs to the patent. The wick is raised or depressed by means of a rack, *m*, cut upon the shelf for the glass chimney, into which a pinion, *n*, works, and this is turned by a rod that rises above the cistern, and is accessible without lifting off the glass shade, as was necessary in former constructions. It is easy to perceive that this lamp can cast no shadow downward on the table.

Sect. VIII.—PARKER'S HOT OIL LAMP.

703. This is a late invention, chiefly founded on the advantage of heating oil previously to its combustion. The cistern, *a* (see the section A, *fig*. 133), is composed of two cylinders, one within the other, the oil being contained in the space between both, expressed by dots; and through the inner cylinder, the chimney of the flame, *b*, passes up to heat the oil in the cistern. The lower part of the chimney is of glass, but the upper part, *c*, is of iron, for the purpose of radiating the heat more strongly against the sides of the cistern, or reservoir, which is assisted by the top of the chimney being notched and bent back. From the cistern, a pipe, *d*, descends to supply the wick with oil, and on it is a stop-cock, to turn off the supply when the cistern is to be charged with oil.

Instead of raising or lowering the wick to regulate the height of the flame, as in the

Fig. 133.

Argand's lamp, the effect is produced by raising or lowering the bell-mouthed glass chimney, which rests on three slips of metal moved by rack-work. The cistern contains an imperial pint of oil, and should be made quite full before lighting the lamp, so as to have no air in it, as that, by expansion with the heat, would cause an overflow of the oil. A shade of a conical form, *e e*, made of paper plaited, and plain white, pierced, or painted, is placed round the light, and to conceal the cistern: it is suspended on a circle of wire, *f f*. The nature of this paper shade is seen better in the external view of the lamp at B. The cylindrical cotton wick, which, we have observed, is stationary, is very short, as a new one is to be put on every day with a cotton stick, that it may burn clear, and prevent the usual clogging of the wick, which takes place when it is suffered to remain in the oil for several days, as is usually the case. That the flame may be more regular, the wicks, as sold, are cut quite true by machinery. More particular directions for managing this lamp are given in a printed paper to purchasers. We must observe that this lamp is calculated to burn the common oils, even the coarse fish oils, without smoke or smell, and thus the inventor considers the common Southern whale oil as preferable for burning in it to the best sperm oil. By using the contrivance called an oxydator, or, what is better, the glass contracted in the lower part, described afterward, the light is made still brighter. We can safely recommend this lamp as throwing down a most agreeable light upon the table. The stand is made of various forms.

SECT. IX.—THE SOLAR LAMP.

704. This is a late improvement of considerable importance, by means of which a simple wicked lamp is made to burn with increased light, and no smoke. *Fig.* 134, *a*,

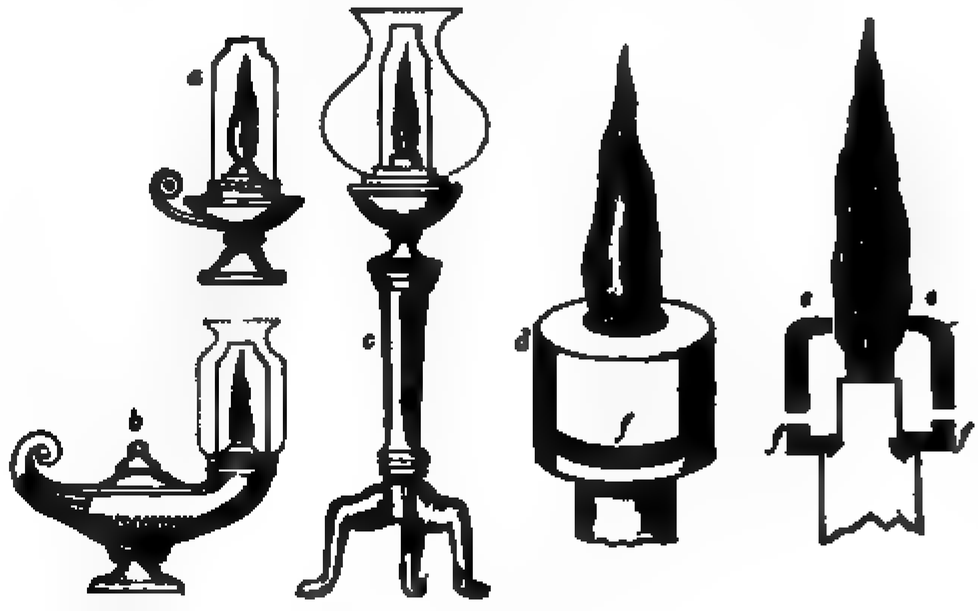


Fig. 134.

b, *c*, represents forms in which they are frequently executed, either for carrying about, or to stand on a table. To the wick must be applied a cap, as represented at *d* on a larger scale, of which *e e* is the section; this has apertures on the side at *f f*, and one at the top, through which the flame issues: by this contrivance a current of air enters at these apertures, and being deflected by the top of the metal cap, is brought into close contact with the flame, impinging upon it nearly at right angles, forcing its way into the flame, and thus supplying it with so much more oxygen than in the usual manner, that the combustion is complete, and the whole of the oil burned, thus entirely preventing the formation of smoke. It is essential that the lower part of the flame should be a little below the aperture of the cap. It is to be observed that there is no current through the centre of the flame, as in Argand's lamp, yet the flame is exceedingly bright. Lamps on this construction, with simple wicks, give no smoke when the best oil is burned, and very little with common oil; they are very economical and agreeable when used in many situations, as in a hall or passage, or other places where the smoke and smell of a common lamp would be objectionable.

705. *But the advantage of this construction is greatest when applied to Argand's lamp.* In the usual construction of this lamp, the current of air on the outside of the wick is made to ascend nearly parallel to the surface of the flame, without being made to strike against it so much as in the solar lamp. The application of the deflector of the solar lamp to the flame of the Argand's lamp produces, therefore, an increased brilliancy of the light. But a still greater advantage in the application of this principle is, that by its means the Argand's lamp can be made to burn the coarse oils without either smoke or smell, equally with the best spermaceti oil. The price of the latter has lately advanced considerably, and at the present time amounts to from six or eight to ten shillings per gallon: whereas the Southern whale oil, when purified, which answers equally well with this new lamp, is sold from three shillings to three and sixpence. The saving is therefore considerable when much oil is used; it is true, the greater consumption is to be considered, but even then the balance is in favour of the solar lamp, both as to economy and light. But to effect this combustion of the common fish oils, a peculiar kind of wick is necessary: it must be more loosely woven than those which are employed for the common Argand's lamp, and somewhat larger; the wicks, as formerly made, would very soon become clogged; the tubes, also, containing the new wick, must be made on purpose for it, and this may be added to the old stem, or other supports of the lamp; an alteration which generally costs from fifteen to twenty-five shillings for each light. By this means any of the ordinary lamps, as the French, or others, may be made to burn the coarse oils. The present high price of sperm oil has given rise to numerous inventions in lamps, to enable them to burn the common fish oils, or the vegetable oils; and these have led to some permanent improvements.

The most usual form in which this improvement of the Argand's lamp has been executed is what is termed the *vase solar lamp*, of which A, *fig.* 135, shows the upper part,

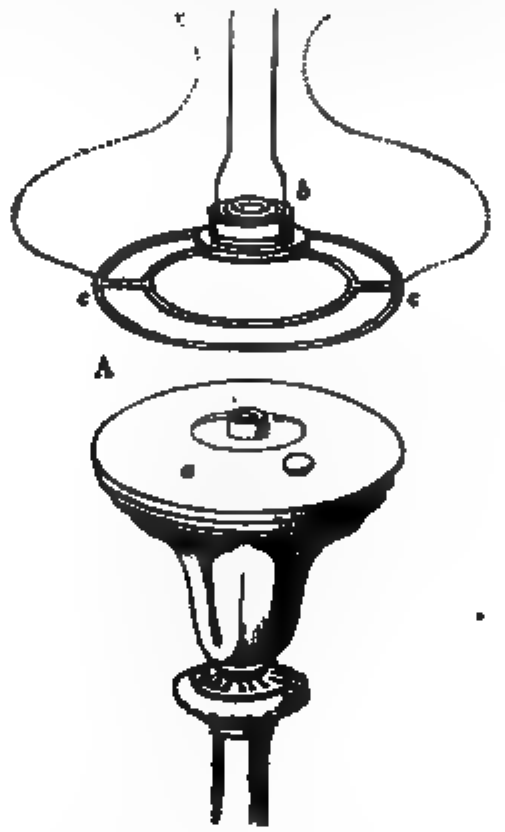


Fig. 135.

and which may be added to any stem of the former lamps: *a* is the reservoir for holding the oil; *b* is the cap with the deflector, and the ring, *c c*, holding the ground glass

shade, fits on the edge of the reservoir *a*. B, *fig*. 135, shows the deflector on a large scale. The air enters through the apertures, *d d*, goes towards the flame of the circular wick in the direction of the arrows, and impinges on the flame at *e e*, the current within the circular wick being, as usual, at *f*.

706. *A still farther improvement* in the solar lamp, as applied to Argand's, has been made by Quarrell, *fig*. 136. By this, besides the usual deflected current shown by the arrows, a second current is produced by air entering at apertures *g g*, which, rising within the glass chimney, keeps it cool, and prevents the breakage it is very liable to by great heat. He also makes this chimney conical, without the usual shoulder.

707. *Various contrivances, called oxydators*, have been produced in consequence of perceiving the advantage of causing the external current of air to impinge upon the flame of the Argand lamp. Some of them consist of small caps of brass, with a wide hole on the top, to admit of the flame of the lamp, similar to that of *fig*. 133, but so that the current of air is obliged to pass upward in close contact with the flame. Making the glass a little wider at bottom, to admit of a flat loose ring of brass, with an aperture for the flame, to rest on the shoulder of the contracted part, as shown by the shaded ring in *a*, answered the same purpose, and has been the subject of a patent. Even so simple a contrivance as a circle of thin mica, *b*, *c*, *fig*. 137, fixed in the inside of a cylindrical glass, with a hole in it a little larger than the flame, has been found sufficient to destroy the smoke of a common lamp, burning common oil.

Fig. 136.

But almost all these contrivances are now superseded by contracting the lower part of the glass itself, in the manner shown at *c*, *fig*. 137, which has the effect of obliging the external current of air in the Argand lamp so to impinge upon the flame that every particle of smoke is destroyed, and coarse cheap oil can be burned. We must observe that this form of glass, which is certainly a very great improvement upon the former cylindrical glass of Argand's, requires very great care, otherwise they are apt to break. For common purposes, the plate of mica, described above, answers very well with those who have sufficient ingenuity to fit them in. A circle of tin plate would do.

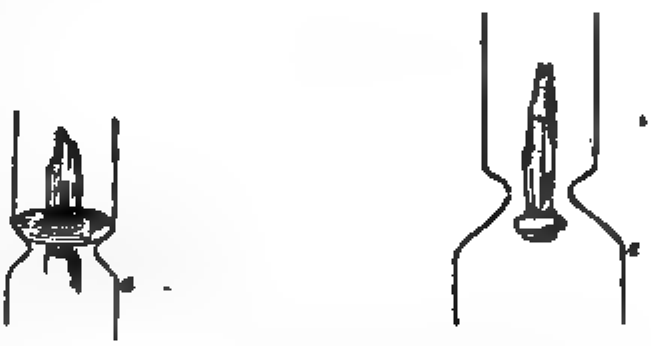


Fig. 137.

Sect. X.—Keir's fountain lamp.

708. *Many attempts have been made to construct lamps to stand on the table with an upright stem*, having the plane on the top in form of a large candlestick or candelabrum, so as to do away entirely with all shadow, or visible reservoir for the oil. The great difficulty is in the supply of the oil for a long time: in the common small candlestick lamp, where the wick is supplied simply by capillary attraction, the lamp burns dim as soon as the oil falls much below the flame; and some means are required for keeping the oil always at the same height. This is effected completely in the Argand's lamp, where the supply cistern is on one side; but the shadow which this casts renders it unfit for the centre of a table; and what is desirable is to have a lamp burning constantly with an equal and strong light, but without any shadow like a candle. To effect this, two methods have been resorted to. one is on a hydrostatic principle, in the manner of Hiero's fountain, where the oil is placed in the body of the stem, and is raised to the wick, as it is wanted, by the pressure of a column of some fluid. In the other method, the oil is forced by clock-work mechanism, as in the lamp by Carcel of Paris. The first successful attempt of this kind, in England, was the lamp invented by Mr. Keir, about 40 years ago, upon a hydrostatical principle; and though it is not used at present, being superseded by contrivances of a similar kind by other manufacturers, yet it will serve to illustrate the general nature of these lamps, of which several varieties have been brought partially into use.

Fig. 138 represents the usual form in which Mr. Keir's lamp was made; but it is to be observed that the form might have been varied to infinity with the same construction, which will be understood from B, which is a section. The vase and its pedestal were both hollow, and two tubes, *a* and *b*, passed down through the middle, one of them only reaching to the top to supply an Argand burner. A heavy fluid, consisting of brine, or a strong solution of salt in water, so as to be three times the specific grav-

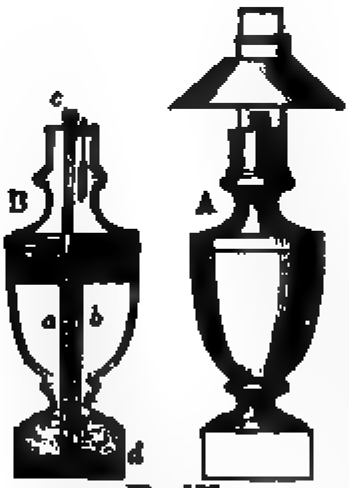


Fig. 138.

ity of oil, was poured in at the side of the burner, marked *c*; this descends down through the tube *b* into the lower vessel or pedestal *d*, and rises up the tube *a*, standing at the same altitude in both tubes. The oil is next poured in at *c*, and thus falling upon the surface of the salt liquor, and swimming on it, by its weight forces up the tube, *b*, into the vase part: the oil and salt liquor balance each other when no more oil can be poured in. Both fluids being now in a state of equilibrium, they will remain in that state until the oil is diminished by the consumption occasioned by burning. The liquor in the vase then presses downward, and communicates an upward pressure to that below the oil in the pedestal, and causes it to rise in the tube *a*. As this pressure of the salt liquor is constant, it keeps the oil at the height of the burner, until it is all consumed. This lamp, therefore, requires no more attention than an ordinary lamp, and is merely to be filled with oil when necessary, the brine remaining always the same. Several other lamps have been constructed on the same principle, as King's, Barber's, &c., though varied in appearance; but these are difficult to manage, except by those who understand the philosophy of them, and when in the least deranged, it is generally necessary to take them to the makers. They are, therefore, not calculated for general use, although some of them have a very elegant appearance as table lamps.

SECT. XI.—PARKER'S FOUNTAIN LAMP.

709. Parker's fountain lamp is another of this kind, which has been reported on by the Academy of Sciences in Paris. A, *fig.* 139, represents its external appearance; but it is executed in various other patterns. Having no ring reservoir like the French lamp, it is obvious that there can be no shadow whatever. The external part, *a*, is in the form of a column, usually bronzed or japanned, to imitate some dark-coloured stone, as porphyry, basalt, &c. Within this is an internal cylinder, the top of which appears at *b*, and which is taken out when the lamp is to be filled with oil. B, *fig.* 139, represents a section of this lamp, the description of which we shall give in the words of the inventor. "Like Hiero's fountain, the interior of the lamp is divided into three distinct compartments: an upper chamber or reservoir, *x*; a middle chamber, *y*; and a lower chamber, *z*. Through the centre of the whole there passes a tube, *c d*, open at its upper end, *c*, and opening at its lower end, *d*, into the chamber, *z*. *e e* are opposite sides of the burner tubes of the lamp, between which is placed the cotton wick, *f*. *g* is the open space in the interior tube for the current of air that supplies the flame, and supports the combustion. If it is now recollected that the proper action of every lamp depends on the constant and uniform supply of oil to the burner, the action of this lamp will be clearly understood by attentively examining the intercommunications between the three chambers and this tube. The upper chamber, *x*, communicates with the tube, *c d*, by a lateral aperture at *h*. The tube, *c d*, opens into the lower chamber, *z*, by a lateral opening, *d*, at its lower extremity. The lower chamber, *z*, opens into the middle chamber, *y*, by an ascending passage, *i k*, the upper end of which is covered (but not closed) by the cap, *l*. The middle chamber, *y*, is in direct communication with the burner tube, *e e*, by the passage, *m n*; the lower end, *m*, of which opens into the chamber, and its upper end, *n*, into the lower part of the burner tube. Now, to consider the action of this arrangement, it will be evident that, if a liquid, as oil, be poured into the tube *c d* at the opening *o*, it will endeavour to fill the chamber *z* by escape at the lateral opening *d*; but this chamber is already occupied by atmospheric air, which must, therefore, be driven off as the oil enters; or, if the construction of the vessel prevents its escape, then, by the known properties of atmospheric air, and the laws of hydrostatic pressure, it will be condensed by the pressure of the superincumbent column of the invading liquid, until its resistance, or the power of its counteraction, becomes equal to the weight of a column of the liquid, of diameter equal to that of the vessel into which it is forced, namely, *z*, and of height equal to that of the column of supply, namely, *c d*. Now, imagine the oil to be thus poured into the chamber *z*, until it be filled; the air it contains will then be driven into the chamber *y* by the

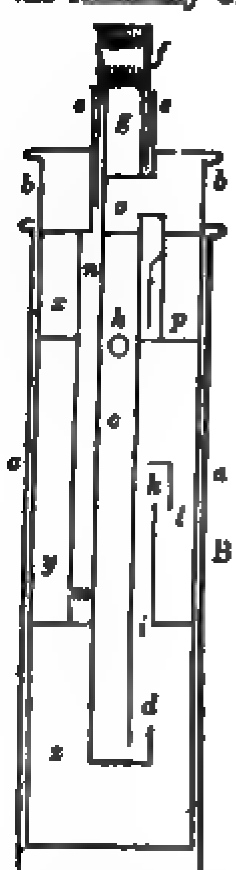


Fig. 139.

passage $i\ k$, and by the tube $m\ n$. Now, if the lamp be placed in an inverted position, the contents of z will run through $i\ k$ into the chamber y. During the passage of the oil from z into y, atmosphere again enters z by the passage $c\ d$; and now, if we again fill $c\ d$ with oil as before, the air that z contains will be condensed, and its counteraction will drive out the oil contained in y by the passage $i\ k$, through the only exit it finds, namely, the mouth of the passage $m\ n$, which, as already described, supplies the wick. It now only remains to say that the operation last mentioned, of pouring in oil at the tube $c\ d$, also fills the upper chamber z by the aperture h, the air it contained escaping through a small tube, p. The contents of this chamber sustain the supply of the tube $c\ d$. It now appears that the action of the lamp depends simply on the tube of supply, $m\ n$, delivering to the wick uniformly enough oil, and with sufficient rapidity, to support combustion, and not so much or so rapidly as to encumber it. This is done by ensuring a just equilibrium between the altitude of the maintaining column, $c\ d$, and the column maintained, $m\ n$." When these lamps are sent to India, a contrivance is added to prevent the flame from being blown out by the action of the puncha, an apparatus for producing currents of air for ventilation, and likewise to prevent the light being extinguished by swarms of moschetoes, as frequently happens. For this purpose a plate of metal, pierced full of very small holes, surrounds the aperture by which the air enters to feed the flame. In the ordinary lamps to be used in this country this plate is perforated, so as to form an ornament having wide openings.

Sect. XII.—Carcel lamp.

710. The Carcel lamp gives, perhaps, the most beautiful light of any for domestic purposes, and is generally used by the opulent families in Paris. The following opinion respecting it is that given by Dr. Ure. In this lamp the oil is raised through tubes by clock-work, so as continually to overflow at the bottom of the burning wick; thus keeping it thoroughly soaked, while the excess of the oil drops back into the cistern below. Its light, when furnished with an appropriate tall glass chimney, is very brilliant, though not perfectly uniform, since it fluctuates a little, but always perceptible to a nice observer, with the alternating action of the pump-work; becoming dimmer after every jet of oil, and brighter just before its return. The flame, moreover, always flickers more or less, owing to the powerful draught, and rectangular reverberatory shoulder of the chimney. This mechanical lamp is, however, remarkable for continuing to burn, not only with unabated, but with increasing splendour, for seven or eight hours; the vivacity of the combustion increasing evidently with the increased temperature and fluency of the oil, which, by its ceaseless circulation through the ignited wick, gets eventually pretty warm; besides, it emits very different quantities of light, according to the differences in the nature and supply of oil, as well as variations in the form and position of the chimney. It is little used in England; nor can it hardly be trusted in the hands of ordinary servants, for, when it gets deranged, it must be sent to its constructor in Paris to be repaired.

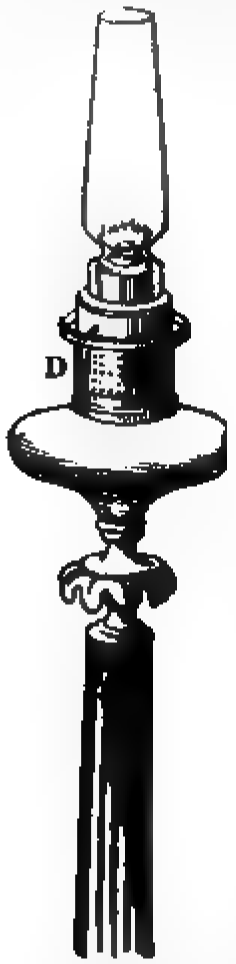
Sect. XII.*—Young's vesta lamp.

710 *a*. The lamp is an instrument of such great and general utility, that it is not surprising numerous attempts are now making to improve it. For many years the lamp of Argand was considered so perfect, that scarcely anything more was thought desirable, and, of course, little or no improvement was made upon it. The French glasses described in p. 180, *c*, *fig*. 122, where the glass was contracted at the level of the flame by a shoulder, was the first improvement on the original construction by Argand, whose glass was simply cylindrical; but by this new form, the air, instead of rising by the side of the flame as before, was made to impinge upon it, thus causing the combustion to be more complete. This effect is still better attained in the solar lamp, invented by Mr. Bynner: his cap of brass (see *figs*. 134, 135, 136) had the advantage of being more durable than the glasses, which are very apt to break. But, as the principle was not new, the patent for the solar lamp could not be maintained, notwithstanding it was the first lamp by which the common fish oil could be burned without smoke. The idea of causing the air to impinge upon the flame in the manner just mentioned was a happy thought that has given rise to other improvements, of which the solar lamp, and the oxydators mentioned in p. 187, are examples; and the glasses have been still farther improved by being contracted in the manner shown at *c*, *fig*. 137, which, indeed, answers all the purpose of the oxydators, except not being so durable.

710 *b*. *Young's patent Vestal lamp*, usually known by the name of the *Camphen lamp*, has advanced nearer to perfection in several respects than any that has yet appeared; and it was only while this article was passing through the press that our attention was directed to this, the latest improvement in lamps. To render the nature of this lamp quite evident, it is necessary that we enter previously into a few details.

All constructions of the Argand lamp, where the oil is made to rise simply by the capillary attraction of the wick, are found to be imperfect, requiring that the oil shall be replenished very frequently, which rendered it necessary to have the oil in a reservoir on one side, that it might be on a level with the flame; but the inconvenience of this reservoir, in causing a shadow, has been already mentioned in our description of that lamp,

and gave rise to the French annular lamp, and others of that class. The solar lamp, having the oil altogether below the flame, is liable to the objection that it will not burn long clear without being replenished with oil. In all oil lamps there is an accumulation of carbonaceous matter upon the wick, less or more according to the purity of the oil and completeness of the combustion. These circumstances, together with the high price of oil, and particularly of sperm oil, the only one fit for the ordinary Argand lamp, have led to several attempts to burn other liquids, as naphtha and turpentine. The disagreeable odour of the former rendered it inadmissible into apartments, and neither it nor turpentine could be employed in the Argand lamp of the usual construction, since their great inflammability rendered them unsafe, when the liquid was at all heated by any metallic part of the lamp coming into contact with it in the reservoir. To avoid this danger, Mr. Young enclosed his liquid in a glass reservoir, and prevented its being in the least heated, by permitting the cotton wick only to pass into it, and the liquid being thinner than oil, easily rose in the wick by mere capillary attraction. After trying several combustible liquids, he found that rectified turpentine was the best adapted for burning in his lamp, which is now frequently known to the public by the name of the *Camphen lamp*, from the name given to this liquid by Mr. English, who had taken out a patent for its preparation.



710 *c*. Young employs a cylindric wick of cotton, but this has a slit at about an inch and a half from the top, represented at E, *fig*. 139,* as upon the mandrel ready to put into the lamp. The lower part of this wick hangs down into the camphine. Instead of this wick being cylindrical, it may consist of two, three, or more flat slips of cotton arranged in a circular form, and held together at the top, where they burn, by a ring of metal.

A, *fig*. 139,* represents the upper part of this lamp, displaying its internal structure. *a* is the cylindrical wick put over a brass tube by means of a mandrel, and *e f* is another brass tube of larger diameter, leaving a space between it and the wick. In the side of *e f* there is an opening, *g*, through which the air is admitted to ascend between the two tubes, to supply the outside of the flame of the wick when it is lighted; and by the same means the air is admitted through the slit in the wick in the inside of the flame. The dotted lines show this wick hanging down into the camphen in the glass reservoir, *h*. The flame at *a* is made to strike on a metal button, *i*, by which it diverges outward like the petals of a flower, which is shown more at large at C, where the dotted line represents the glass with its contraction. The brass cap, *k*, carrying what has been described, screws on to another brass cap, *l*, fixed to the glass reservoir, *h*; and to prevent all communication of heat to the camphen, a piece of wood is interposed between the two caps, as being a bad conductor. The whole of this apparatus may be fitted into the stand of an ordinary lamp by means of the glass foot, *m*.

B represents the same upper part as completed by some additions; *n* is a perforated cylindrical tube to conceal the aperture by which the air is admitted to the flame; *o* is the part necessary for inserting the bottom of the glass represented by the dotted line; and *p* is a screw by which the height of the wick is adjusted; *q* is a stage on which rests a ground-glass moon to soften and distribute the intense light of the flame.

D represents the lamp complete on a stand, but without the ground-glass moon, or conical paper shade, which is sometimes also used, as is represented in Parker's hot oil lamp, which throws down a strong light round the foot of the lamp.

710 *d*. One of the great advantages of the Vesta lamp is, that there is no deposition of carbonaceous matter upon the wick, provided the camphen is used quite fresh; and from the simplicity of its construction, the management of it is easy, the wick requiring merely to be cut even every time it is used; nor is this even always necessary, as there can be no overflowing of the liquid, a defect to which the Argand lamp is liable, and which demands the addition of a cup to catch the oil that may drop; here no cup is required, nor is the turpentine liable to damage the carpets and other furniture in the same manner as oil. But it is proper to observe that the camphen must be kept quite

close from the air in a tin can, and no more poured into the reservoir than is required for one burning, or at most two, because the rectified turpentine attracts oxygen from air rapidly, and what has been exposed for a day or two in the reservoir is not fit for combustion, as it will give smoke. The proper rectification of the turpentine appears to be essential to the success of this lamp. Another precaution must be mentioned, which is, that the liquid, being highly inflammable, the greatest care must be taken that it does not take fire by any accident in filling the reservoir, or pouring it out in any way; since, in case of such accident, the flame is violent and difficult to extinguish; but it is to be observed that the turpentine is not very easily inflamed, except when heated, which it is not liable to be in the glass reservoir on the construction above mentioned; but this effect would happen were it used in a common Argand lamp, or any other lamp having a metal tube going into the liquid. The total absence of such a tube is one of the peculiarities of the Vesta lamp.

710 *a*. *The printed report by Dr Ure* is subjoined, not only as stating some properties of this lamp, but because it affords information respecting combustible liquids:

"The Vesta lamp, burning with its utmost brilliancy, without smoke, emits a light equal very nearly to twelve wax or sperm candles of three or four to the pound; and in so doing it consumes exactly one imperial pint of spirits of turpentine (value sixpence, retail) in ten hours; hence the cost per hour for a light equal to ten such candles is one halfpenny, whereas that from wax candles would be nearly sixpence; from spermaceti ditto, fivepence; from stearin ditto, fourpence; from Palmer's spreading wick, ditto, nearly threepence; from tallow moulds, 2½d.; from sperm oil in Carcel's mechanical French lamp, 1½d. One peculiar advantage of the Vestal lamp is the snowy whiteness of its light, which is such as to display the more delicate colours of natural and artificial objects, flowers, paintings, &c., in their true tints, instead of the degraded hues visible by the light of candles, and ordinary oil lamps.

"The size of the flame from which so much light is emitted in the Vesta lamp is greatly smaller than that of oil or gas Argand flames of equal intensity; a circumstance to be accounted for from the difference in chemical composition between spirits of turpentine and fat oils. The spirits consist entirely of carbon and hydrogen, in the proportion of 88½ of the former element and 11½ of the latter, in 100 parts, and they consume 330 of oxygen; whereas sperm and other unctuous oils consist of 78 carbon, 11½ of hydrogen, and 10½ of oxygen, in 100 parts; and these consume only 287·3 of oxygen in being burned, because the oxygen already present neutralizes 9·6 parts of the carbon, and 0·4 of the hydrogen, thus leaving only 88½ parts of the combustible elements of the atmosphere to burn; for this reason 87½ parts by weight of spirits of turpentine will consume as much oxygen as 100 parts of sperm oil, and will afford, moreover, a more vivid light, because they contain no oxyde, as fat oils do, which serve to damp the combustion. In the spirits of turpentine the affinity of its elements for oxygen is entire, whereas, in fat oil, the affinity is partially neutralized by the oxydes it contains, somewhat as the flame of spirits of wine is weakened by their dilution with water."

Mr Young has also prepared lamps upon similar principles, but on a smaller scale, in several forms, for giving light to chambers of various sizes. To this we may add that the principle of Mr Young's lamp, by which air is admitted to the interior of the flame by a slit in the wick, is applicable also to the solar lamp burning oil, with a ring flame, to the interior of which hitherto the air has been admitted only from below, by a tube passing down through the reservoir.

Sect. XIII.—Lamps for Reading.

711. *A lamp for reading, writing, or drawing* should have the light thrown immediately upon the most convenient part of the table.

An Argand's lamp, with a conical shade, forms an excellent lamp for these purposes; but they consume more oil than is usually required, and, consequently, give too much heat. If the hollow wick is made very small, it is difficult to get the lamp to burn well. A flat wick, well trimmed, with a glass chimney, and the best oil, such as watchmakers use, make a good economical lamp for these purposes.

712. *Fig.* 140 *is another lamp on a superior construction* for the same purpose. *a* is a tin cylinder, containing the oil, which has a valve at the bottom, made to open by a wire in the same manner as the fountain lamp. In this lamp the wick is flat, or it may be circular, upon the plan of Argand's. It is made of tin, japanned, and is much used by engravers; though not so elegant as some others, it forms a powerful reading lamp, price ten shillings.

Fig. 140.

713. *The Rumford lamp*, A, *fig.* 141, was first made with a flat wick, and, though not elegant, is a good reading lamp. It may be used with an Argand burner. B, *fig.* 141, is a reading lamp with a reservoir for oil, on the principle of the French circular lamp.

714. *The University lamp*, A, *fig.* 142, is much used as a reading lamp; it is on the Argand principle, with a small wick; but as the reservoir is not above the light, it does not burn many hours without replenishing.

715. B, *fig.* 142, *represents a reading lamp of an uncommon construction.* The shade is double, and serves also as the reservoir for the oil between the two thicknesses; the lamp is Argand, and being supplied from a higher source than the flame, has the advantage of burning long. The inside of the shade is japanned white; and the whole outside is gilt. This lamp will be peculiarly useful where it is required to have a very strong light on the table.

716. *A globe of glass filled with water*, with a light placed before it, is used by the French peasants who make lace; by this means the light of a single lamp is thrown with extraordinary vividness along a whole range of these industrious workers.

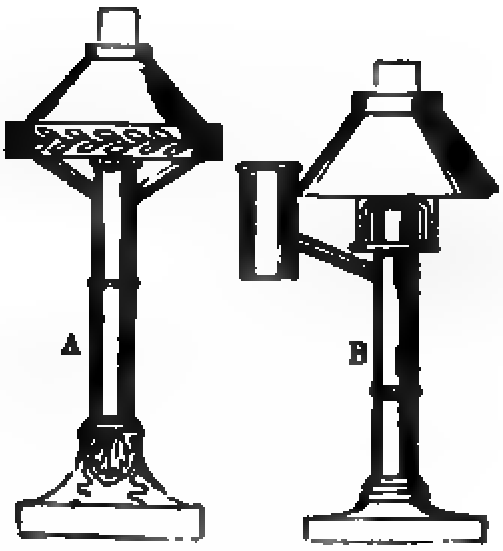


Fig. 141.

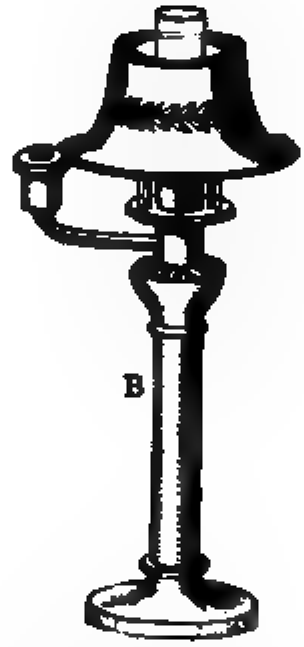


Fig. 142.

Sect. XIV.—LAMPS TO BURN SOLID OILS.

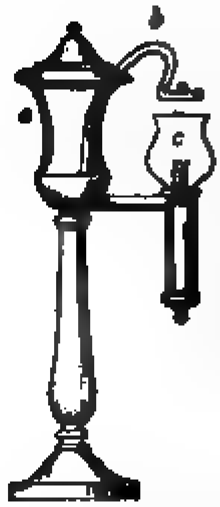


Fig. 143.

717. *Lamps to burn oils that are not sufficiently solid to make into candles, and yet too thick to burn well in common lamps*, as palm oil, tallow, hogs' lard, &c., require a particular contrivance. A piece of metal is made to come over the flame, so as to be heated by it, and then this piece communicates with the oil in the reservoir, which is, by the heated metal, kept always in a liquid state. The Hon. E. Cochrane took out a patent for a lamp of this kind. *a*, *fig*. 143, is the reservoir in which the material is to be burned; *b* is a bent metal rod, one end of which comes over the flame *c*, and the other passes into the interior of the reservoir, among the solid matter, which is thus melted by its heat, and enabled to flow to the wick.

Sect. XV.—WAX LAMPS.

718. These are found more convenient for some purposes than wax candles, as, the flame being always at the same height, anything may be boiled or warmed over it with more ease. Travellers have found them useful in this way for keeping coffee warm, or water for shaving; and they have this advantage, that the wax very soon gets solid after the flame goes out, so that the lamp with its wax may be packed away among the luggage without danger; whereas it is almost impossible to keep an oil lamp from doing some kind of damage. A cup is sufficient for holding the wax; and the burner, of tin plate, may stand in the middle of it. The wick should be of cotton thread, dipped in wax, and cut into short pieces; when one is consumed, it is sufficient to pierce the wax with a large pin down to the burner, and introduce a fresh one. The best way of extinguishing wax lamps, so as to preserve the wick for re-lighting, is to overcharge it with wax, by holding a piece of wax over it till it melts and falls on the wick, reducing the flame, which may be then put out by a gentle puff.

Sect. XVI.—LAMP WITHOUT FLAME.

719. *A curious night lamp, without flame*, is made, *fig*. 144, from a philosophical principle discovered by Sir Humphrey Davy. If a cylindrical coil of very thin platina wire be placed partly round the wick of a lamp with spirits of wine, and partly above the wick, and the lamp be lighted so as to heat the wire to redness; on the flame being blown out, the mere heated vapour rising from the spirits of wine will be sufficient to keep the upper part of the wire red hot for any length of time that the spirit remains. This beautiful and simple contrivance will give sufficient light to see the hour of the night by a watch, or to do anything that requires very little light, and will not be liable, as a flame, to disturb persons not accustomed to burn a light. It has also the convenience of being always the same, requiring no trimming, and being peculiarly safe, as it can give no sparks. Its heat is sufficient to kindle German tinder, or paper prepared with nitre, and thus to light a sulphur match. The size of the platina should not exceed one hundredth of an inch. A coil of twelve turns is sufficient. When the wire collects a crust round it, it

Fig. 144.

may be brightened, and made to act as well as at first, by uncoiling and rubbing it with fine glass paper

This curious effect is produced by the heat of the wire being sufficient to cause the invisible vapour of the spirit to combine with the oxygen of the atmosphere, and thus to burn, although the heat is not great enough to occasion that kind of combination which gives rise to the emission of light. It is, in fact, an *invisible* combustion of the vapour of the spirit which continues to rise, and which, being extremely inflammable, was set fire to by the red-hot wire in the first instance; the constant production of vapour, through evaporation, causes its invisible combustion to maintain the wire in a state of red heat as long as it is immersed in it. As the decomposition of the alcohol, and the union of its hydrogen and oxygen, give rise to acetic acid, which has an unpleasant odour, it has been proposed to use *eau de Cologne* instead of spirits of wine, which would diffuse an agreeable fragrance. With respect to this lamp, it must be observed that it is to be considered rather as curious, and illustrating some chemical principles, than as particularly useful.

Sect. XVII.—CARRIAGE LAMPS.

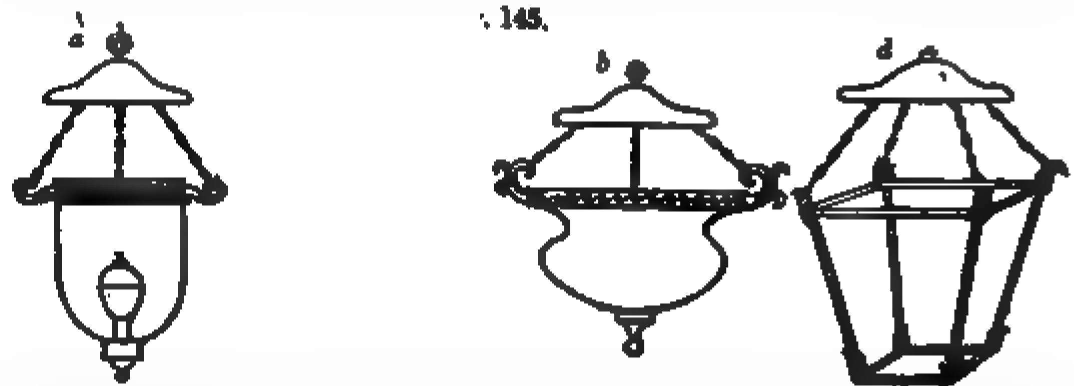
720. In ordinary carriages for travelling, the light is an oil lamp of the common kind, with either a round or flat wick. Attempts have been made to use Argand's lamps, but hitherto without success, as they are liable to be extinguished by a violent draught of wind. In carriages of the best kind, wax candles are used for the light, on account of their superior cleanliness, although their light is inferior to oil.

The wax candles are contained in tin tubes, through a hole in the upper part of which the wick passes, the candle being pressed upward as it is consumed, by a spiral spring. In dress carriages the lamps are more ornamental, consisting of circular boxes of glass, in which are burned wax candles. The lamps of travelling carriages are square, and have wooden slides to shut before the glass in the day: sometimes they have reflectors.

Sect. XVIII.—HALL LAMPS.

721. These are either of the vase kind, when small, as *a* and *b*, *fig*. 145, or consist

Fig. 145.



of panes of glass in frames, as *c* and *d*; and the lights may be, in the first case, simple lamps with one or more wicks, or Argand lamps, when a stronger light is required. Of course, it is essential that a supply of air shall be given to the light by proper openings in the containing vessel. A glass is suspended over the lamps, when they are not Argand's, to collect the smoke, which otherwise would blacken the ceiling.

Sect. XIX.—CANDELABRA.

722. *Candelabra are elegant stands*, or supports, to place lamps upon, or they are stands terminated at the top by branches for candles. Such stands were in common use among the ancients, from whom we have adopted them. Of antique candelabra, great numbers have been found in Italy, and form some of the finest examples of exquisite taste in design and execution. They are of two kinds: those of a large size in marble, as *a*, *fig*. 146, which were used in temples or in large halls, and sometimes contained braziers, or basins on the top, for holding combustibles. Some of these bear a resemblance to altars, and were perhaps used for burning incense. A very fine antique marble candelabrum may be seen in the Townley Collection in the British Museum. The other kind was of bronze or other metals, as *b*, *c*, of a more slender form, and were chiefly employed in domestic edifices. Great numbers of them have been found in the excavations in Herculaneum and Pompeii, and are to be seen in the museum of Portici. In many of these the shafts represent a knotted cane, or a spiry branch, with truncated shoots and leaf stalks. They may be cited as instances of the taste with which the ancients adapted ornaments to things of common use, at the same time preserving the type of the objects which gave rise to any useful invention. Cicero informs us that, in Sicily, no great house was without some of these utensils, made of silver. In modern times, the invention of candles occasioned this kind of elegant furniture to

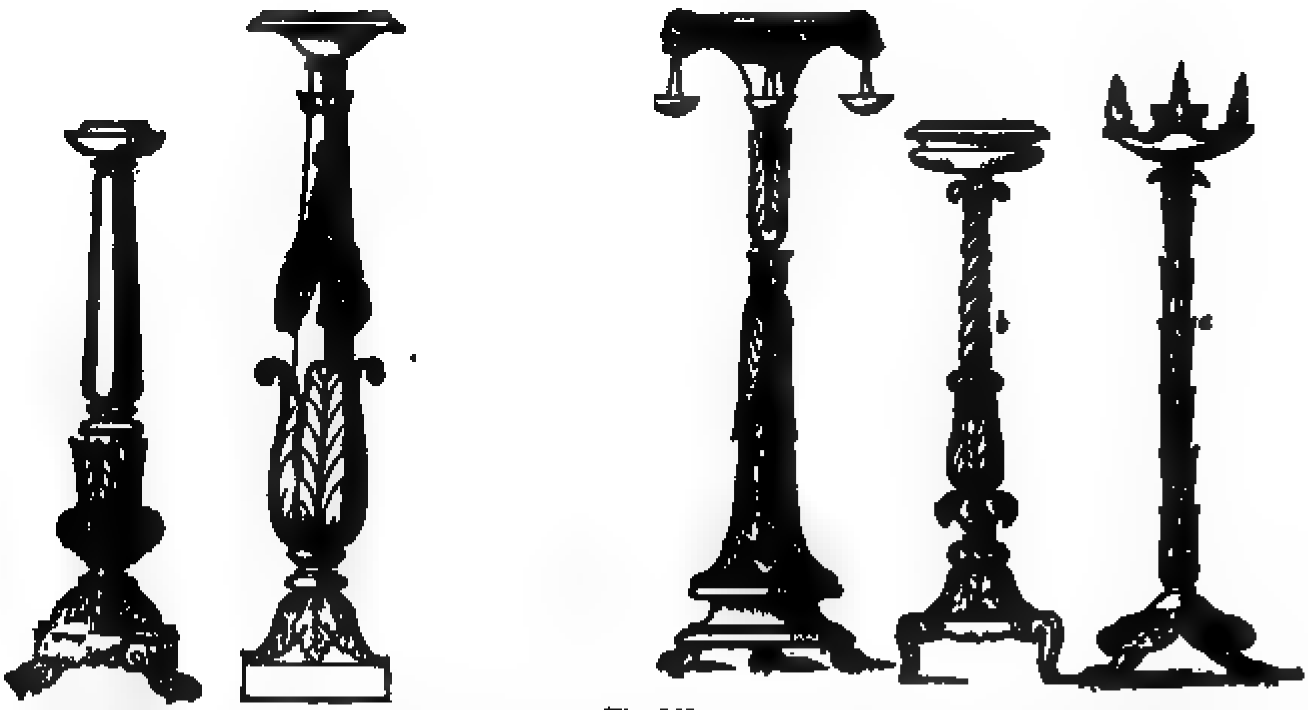


Fig. 146.

go out of use. In Italy, the practice of placing round the altars in churches large chandeliers to hold wax candles seems to be in an imitation of ancient customs, and the size and shape of some of these preserve a tolerably just idea of the ancient candelabra; but they differ essentially from them, in having a socket for the candle, and still more in the choice of forms and taste of ornament. Of late, it has been the fashion here, in the houses of the nobility and wealthy, to have candelabra in elegant apartments, to support lights of various kinds, and many of these are accurately copied from the antique, or designed in the same style.

SECT. XX.—VERY INTENSE LIGHTS.

723. The intensity of the light, in some cases, is very important; and this has occasioned some very accurate experiments to be made upon the various substances employed for producing light. The various animal and vegetable oils have been tried, of which spermaceti oil has been found to give the most light: cocoanut oil is inferior. Gas has likewise been tried, but nothing was gained in intensity of light.

724. *In lighthouses*, it is not only necessary to have a strong light, that may be seen at a great distance, but it is required likewise to have the lights varied, so that the light of one lighthouse shall be distinguishable from that of another. For this purpose, three kinds of lights are employed: a fixed white light; a revolving light, which shall appear and disappear for a minute or two alternately; and likewise coloured lights; the latter are produced by the use of coloured glasses.

725. *The concentric wick lamp, with a double current of air*, was first invented by the writer of this article, upward of thirty-five years ago, and was announced by Sir H. Davy, at the Royal Institution, as very useful for chemical purposes, affording a much more intense heat and light than any lamp at that time made. It consists of two circular wicks, like Argand's, one within the other, and, of course, two concentric flames. A great many of them were sold by Messrs Accum and Garden, Compton-street, London, for chemical purposes. A lamp on the same principle, with four concentric wicks, has since been constructed by M. Fresnel, for lighthouses, which, according to Dr. Brewster, gives a light equal to forty common Argand flames. An inconvenience in the use of these double wicked lamps, when used for ordinary light, is the intense heat they produce, which is, however, very advantageous in a chemical laboratory.

726. *The most intense light that can be produced* is that known here by the name of the *oxy-hydrogen light*. This method consists in projecting a stream of oxygen gas, and another of hydrogen gas, brought into union, in an ignited state, upon a small ball of lime. The light produced is, indeed, so intense as to be insupportable to the eye. By a small ball of lime, only three eighths of an inch in diameter, so brilliant a light is emitted, that it is equal to thirteen Argand lamps united, or 120 wax candles. This light has been successfully employed in various ways: as signals, in surveying; in lighthouses; and in illuminating the microscope, by which means an extraordinary

magnifying power can be used. Exhibitions of these microscopes are now well known: the light is in that case passed through a lens, and it throws the images of objects magnified from 10,000 to 500,000 times, in the manner of a solar microscope, upon a disk of fourteen feet in diameter. It is proper to mention that the original invention of this light does not appear to belong to Lieut. Drummond, as it has been claimed by Prof. Silliman, of North America.

727. *In the original Bude light*, invented by Mr. Gurney, the light was produced by passing a stream of oxygen gas through the wick of an Argand oil lamp; in consequence, a most intense and beautiful light was formed. But the light now known as the Bude light is stated to be "nothing more than an ordinary gas flame from three or more large concentric Argand burners, the air passing up through the centre being only atmospheric air, with chimneys and reflecting apparatus of particular construction." In this latter case, the principle appears to have been borrowed from the concentric wick lamp described above. The Bude light has been found very advantageous in large interiors, such as the House of Commons, and churches.

Sect. XXI.—Management of Lamps.

728. *From the great heat which fixed oil gives out in burning, it scorches and chars the wick*, changing its texture, so that it does not imbibe the oil so fast as at first. The oil also deposites, and particularly the impure oils, a quantity of carbonaceous matter upon the wick, which, constantly accumulating, clogs it to such a degree that the oil cannot ascend, causing the lamp to burn dim. On this account, after a lamp has burned a certain time, it is necessary to cut off the portion of the wick that has been so acted upon, and to kindle the portion below it. This is called *trimming the wick*. A remedy for this has been attempted by making the wick of incombustible materials, as asbestos or wire; but this has not succeeded. There is, however, a considerable difference in various oils, with respect to their liability to clog the wick. The purer the oil, the better will be the light it gives; and it will, in general, in the best lamps, be found most economical to use the best oil instead of the cheapest; bad oil occasioning smoke, much trouble, and injury to the lamps.

729. *Lamps in which the wicks lie horizontally*, and that come in contact with the air, are not so liable to gather this accumulation of coaly matter as those which are upright. The wick of the Argand lamp also collects very little, on account of the current of air inside and outside the flame. A number of small wicks, placed near together, will not accumulate so much black matter as a single large wick, because in the small wicks the air penetrates into the group of flames.

730. *Although fixed oil remains fluid at our ordinary temperature, yet it congeals in very cold weather*. It becomes thick, and though not quite solid, yet too much so to be drawn up by the wick. When it is found in this state, it must be placed at a little distance from the fire to make it become liquid. It may be interesting to mention that the thickening of the oil by cold is an imperfect kind of crystallization; and that Dr. Clarke found at one time, that it had formed regular crystals; the temperature 35°.

731. *In the management of the simple lamp*, several things are necessary to be observed. The wick should not be twisted too much, for if it be too compact the oil will not rise readily in it; nor should it be too loose, for this will cause the capillary attracting power to raise too much oil. With regard to the distance of the flame from the surface of the oil, if it be too near, too much oil will be raised, more than can be readily consumed; in consequence the light will be weak, and the flame will be in danger of being put out. If the distance be too great, the capillary attraction will not raise oil enough. From this it is obvious that most lamps require constant attention to the wick, otherwise the light will be very unequal. It is an improvement to have the wick pass through a very short tube, which assists in raising oil equally.

732. *Cotton is found to be the best material for forming wicks;* so remarkably is this the case, that spun cotton was imported from the Levant for the wicks of lamps in England, ages before it was made use of by the weaver.

733. *Argand lamps require particular care*. It is necessary that they should be trimmed daily; and they should be thoroughly cleaned out twice or thrice every year by pouring warm water into them, having a little pearlash dissolved in it; this will bring away the oil that has thickened and collected in the tubes, thus clogging them up and preventing the passage of the oil and air. The alkali or pearlash in this operation combines with the oil, and forms a soap, which, being soluble in water, easily comes out by agitation. Warm water alone might melt the oil, but it could not dissolve and bring it away like the alkali.

It is also necessary, in trimming, that the wick should be cut *perfectly* level with scissors; any ragged bits on the edge of the wick occasion the flame to be uneven and to smoke in some places. Care should be taken that the holes through which the air is supplied to the interior of the flame are not stopped up, as they are apt to be, with bits of cotton, tow, and oil, during the cleaning and trimming; if they are clogged, the supply of air is not sufficient, and the lamp will smoke.

SECT. XXII.—EXPEDITIOUS METHODS OF PROCURING LIGHT.

734. There are many occasions when there is a necessity for procuring a light where no fire is at hand; either for the purpose of kindling a fire, or of lighting a lamp or candle; and though most of these methods are now pretty well known in this country, yet it will be proper to say something respecting them, to point out the advantages of each, and, in some cases, the danger in using them.

735. *Flint and steel.* This simple and ancient method of procuring a light is still one of the best, notwithstanding several late inventions have some advantages. The flint made use of is of the same kind as is used in muskets and fowling-pieces, but the pieces are of a larger size, and are made somewhat of a wedge form, for the convenience of striking fire more readily; this kind of flint is found nowhere but in the chalk strata. The steel usually employed is made of a convenient form, and should be well tempered; an old file will do as a make-shift upon occasions when no proper steel is to be had.

It is important that the tinder should be carefully burned and kept dry; the brimstone matches are well known. When the flint, steel, and matches are in perfect order, nothing is more easy than to procure a light by this apparatus, and its perfect safety is a great recommendation; a single stroke of the flint is generally sufficient to set fire to the tinder, and the match lights by slightly blowing up the ignited tinder; and yet how often do we hear repeated hammering with the flint and steel before the desired effect is produced? The cause is generally this: the flint, which is not expensive, has been so much used, that all its sharp edges are worn off, and these are necessary to act upon the steel; or the tinder is damp, or badly made, or in too small a quantity. To keep a tinder-box in order, the flint should be renewed when it is too much worn, for which purpose a stock should be at hand, or by dexterously breaking one of the sides with a hammer, a new sharp edge may be procured. For keeping bad tinder there is no excuse. The cause of the appearance of sparks of fire when flint and steel are struck against one another deserves to be explained. The sparks do not come from the flint, as is frequently supposed; but they are little chips of steel which are cut off by the sharp edge of the flint, the heat produced by the sharp blow or friction of the flint and steel together being so great as to set fire to and melt in a red hot state the little bits of steel struck off; for steel is really an inflammable substance, although a piece of it cannot be burned in an ordinary fire; but to show distinctly the inflammability of steel, it is only necessary to throw a pinch of steel filings into the fire or across the clear flame of a lamp, and it will be seen that they burn with a vivid light. To prove that the sparks are only little red hot and fused bits of steel, strike them over a sheet of white paper, and having collected them when cold, examine them by a good magnifying-glass, and it will be seen that every one of these consists of a little rounded ball of black scoriaceous iron or steel, that has been burned, and rendered brittle, and is analogous to those which fly off in smiths' shops when hammering iron.

Tinder is linen rags reduced to charcoal, which is more inflammable than the rag itself. The heat of this, however, in so small a quantity, is not sufficient to set fire to wood; and therefore the ends of the matches are covered with sulphur, which kindles with the small degree of heat excited by blowing the tinder. When once the sulphur or brimstone is perfectly kindled, it sets the wood on fire. It may be observed that the temperature of the blue flame of the sulphur is inferior to the bright flame of the wood in the match, since the former will fail in kindling many substances that the latter will set on fire; as, for instance, the wick of a candle. In cases where no tinder can be procured, other light inflammable substances may be used; as extremely dry leaves; cabinet-makers sometimes employ very fine deal shavings.

736. *German tinder or amadou*, which is so easily ignited by a spark from the flint and steel, is made of a species of fungus called *Boletus ignarius*, that grows upon the barks of trees. It is beaten well to make it soft and pliable, and then boiled in a solution of saltpetre to render it more liable to catch fire. The Germans use it much for lighting their tobacco-pipes; and sometimes keep it burning all night for this purpose, a practice extremely dangerous.

Loosely-twisted cotton, dipped in a solution of nitre, has been found to prove a substitute for the amadou, and to kindle equally well.

737. *The match syringe* is a mode of lighting tinder by condensed air. A small piece of tinder is put into the end of a metal tube, and the bottom screwed on; into the other end a piston that fits tight is inserted; when this is forced suddenly to the bottom, where the tinder is lodged, the latter is ignited, and, by unscrewing the bottom, may be taken out ready to kindle a match. This curious effect is owing to the disengagement of the latent heat contained in the air, condensed or compressed by the syringe.

738. *A burning-glass* affords another method of obtaining a light when the sun is sufficiently powerful. This is a convex lens of glass, which, by conveying all the rays of the sun that fall upon it into a small space at its focal distance, occasions a degree of heat in proportion to the size of the lens. A glass of an inch and a half in diameter, or even less, is sufficient to set fire to any light inflammable substances, of which am-

adou or German tinder is the best. Very large lenses are capable of exciting a degree of heat superior to that of a furnace; the most powerful glass of this kind was thus made some years ago by Mr. Parker of Fleet-street.

739. *The air lamp* was an apparatus for procuring an instantaneous light by acting on inflammable air by electricity; the inflammable gas was contained in the lower part of the vessel, and was forced out through a pipe, when it was wanted, by the pressure of water in the upper part. An electrophorus was at the same time made to give a spark, which fired the gas and produced a flame. It was, however, found difficult to keep in order, and there was some danger of explosions; it is not now used: See *Rees's Cyclop.*, art. *Air*.

740. *Garden's platinum light.* A very curious discovery was made in 1824, by Professor Dobreiner, of Jena, who found that platinum, prepared in a spongy form, possessed the singular property of causing a jet of hydrogen gas thrown upon it to inflame in consequence of its union with the oxygen of the atmosphere; and the heat thus excited is sufficient to render the platina red hot, at which a match may be lighted. Upon this principle an apparatus for procuring an instantaneous light has been constructed by Mr. Garden, 272 Oxford-street, London, as follows: *a* and *b*, *fig.* 147, are two glass vessels, the neck of the upper one being fitted air-tight into the lower by grinding. A hollow cylinder, *c*, is fixed upon the neck of the vessel *a*, and reaches more than half way down into *b*; round this tube a piece of zinc is wrapped. A quantity of diluted sulphuric acid is poured into the vessel *b*, which, acting upon the zinc, produces the hydrogen, which rises to the top of the vessel, but, not being able to escape, it collects there, and forces the acid to ascend through the tube into the upper vessel, the air in which escapes through the stopper loosely fitted. As soon as the production of hydrogen has gone on so far as to occasion the acid to descend to the lower part of the zinc, all farther action, of course, ceases, and the upper part of *a* remains filled with the gas. From this part of the vessel, a tube, *d*, projects, furnished with a stop-cock, and the extremity of this tube turns downward, terminating in *e*, where a jet of hydrogen issues on opening the cock. Immediately below this is a little cup, *f*, to hold the spongy platina; and this cup may be moved farther off or nearer by means of the wire, *g*, which slides up and down through a collar. When a light is wanted, the cock is turned, a jet of hydrogen falls upon the platina, which inflames the hydrogen, and is itself made red hot, and capable of igniting a match. This glass apparatus is sometimes, for security, fitted up in a mahogany frame of elegant form, and is extremely convenient in a library or bedchamber, being quite free from the usual objections to apparatus of this kind. It will continue fit for use until the zinc becomes quite dissolved or the acid saturated, when it must be replenished with these materials. The little cup with platina is secured from damp and dust by a brass cap; and should the platina, by dampness, lose its property of igniting the gas, it may be restored by heating it on the blade of a knife over a spirit lamp, or clean candle.

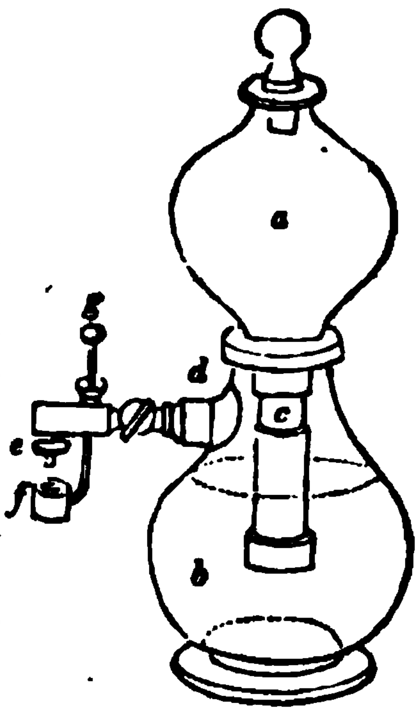


Fig. 147.

The spongy platina is prepared by moistening the muriate of ammonia and platina with a concentrated solution of ammonia; the paste formed is to be heated to redness in an earthen or platina crucible.

741. *Pyrophorus.* Several prepared substances take fire on exposure to air, without the application of heat, which were formerly used occasionally for obtaining a light: a substance of this kind was called by chemists *pyrophorus*; and though better methods have since been invented, it may be useful, on some particular occasions, to be acquainted with their composition. *Homberg's pyrophorus* was the oldest discovery of this kind. It was made by mixing three parts of alum with two or three parts of honey, flour, sugar, or any animal or vegetable matter: this mixture is to be heated in a crucible till the mass is burned black; or, to save trouble, burned alum may be mixed at once with charcoal powder. This is now to be put into a vial, or a matrass, with a neck six inches long. The vessel, however, must not be charged above three quarters full: it is then to be put into a crucible, and surrounded by sand; the crucible is to be put into a furnace among red-hot coals, and kept in a red heat for a quarter of an hour, till a sulphureous blue vapour appears, and the fire is to be kept up till this disappears. The matrass is next to be removed, and its mouth kept closed for some time. The powder is then to be taken out and kept in a vial, with a glass stopper. A little of the pyrophorus shaken out on an easily-inflammable substance, such as dry cotton, will set it on fire immediately. A very good pyrophorus may be made by simply mixing three parts of alum with one of wheat flour, calcining them in a common vial, well stopped with a good cork, when cold.

742. *Phosphoric fire bottles.* Phosphorus takes fire very readily when rubbed, which property has been employed in procuring an instantaneous light. A common match is

dipped into a small bottle containing phosphorus, a minute portion of which adheres to it; the match is then rubbed lightly upon a smooth piece of cork, which causes instant combustion. The manner of putting in the phosphorus is the following: a very small glass vial is procured, and any substance put in to fill it within a small distance; then eighteen or twenty grains of phosphorus is cut into small pieces and put into the remaining part of the vial, leaving room for the cork. The part of the vial containing the phosphorus is heated cautiously with a blowpipe till the phosphorus melts, and the bottle is completed. These fire bottles are rather dangerous.

743. *A fire box is made* by dipping matches charged with chlorate of potash (formerly called oxymuriate of potash) into sulphuric acid, which causes instant ignition. These boxes have been very much used. The matches are prepared by dipping them into oil of turpentine, and drying them; a mixture is then made of an equal weight of finely-powdered chlorate of potash and flowers of sulphur, to which is usually added about an eighth part of vermilion, merely to colour it. This compound is then mixed up with oil of turpentine to the consistence of a paste, and the points of the matches dipped into it. Some asbestos is put into a very small vial, and on that a few drops of strong sulphuric acid: the use of the asbestos is merely to prevent the acid from doing mischief by spilling. Some use sugar instead of the sulphur, and employ spirit of wine to make the paste. Vast quantities of these are used in Paris, and are got up in circular paper cases at a very small expense. It is necessary to put those who attempt to make their matches upon their guard against serious accidents which may happen in the process. The mixture will explode by friction or percussion in a mortar, and the explosion of a few ounces might prove fatal. The substances, therefore, must be rubbed together very gently. But we would not recommend any one to attempt making these matches, except they are well instructed in the necessary precautions. The front of a shop has been blown out by an explosion of this kind, and the operator was seriously hurt.

744. *Prometheans* for procuring an instantaneous light appear as little rolls of paper that contain some red substance enclosed at one end. When you wish for a light you lay the red end of the paper on a table, and give it a knock with a hammer, key, or other hard body, on which the paper inflames. The principle upon which this effect is produced is the following: it is a chemical fact that a mixture of the substance called chlorate of potash with sugar inflames when it comes into contact with sulphuric acid. Now the red substance in the paper is this mixture, and in that substance there is a little glass hollow bead that contains sulphuric acid. When the end of the paper roll is struck, the bead is broken and the acid liberated, which inflames the chlorate. The making of prometheans is rather a difficult operation, and we would not recommend any one not well versed in chemical experiments to attempt it, as the substances are extremely apt to explode by handling.

745. *Lucifers* or *Congreves* are matches prepared by dipping them into phosphoric preparation, which is inflamed by being rubbed sharply on a piece of glass paper, or any other rough substance. They are, perhaps, on the whole, the most convenient and the safest of any contrivance of this kind, as they are not liable to spoil by keeping, nor to inflame spontaneously. They are, at present, sold at a very low price. For safety, they should be kept in a metal case, as friction by some accident may set them on fire

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CHAPTER V.

ILLUMINATION BY MEANS OF GAS.

746. *History of gas light.*—Illumination by means of inflammable gas affords one of the most striking instances of the adaption of scientific discovery to the comforts and elegances of life; and it is the more remarkable, since this vast improvement is altogether within the memory of many persons now living.

747. *It had been shown by Dr. Clayton, in* 1688, that the air which comes from bituminous coal, when subjected to a red heat in a retort, is inflammable, and burns with a bright flame. Dr. Watson, bishop of Llandaff, also, in his "Chemical Essays," mentions his having ignited gas produced by the distillation of coal.

748. *Mr. Murdoch, engineer to Messrs. Watt and Boulton, was the first person who put in practice the idea of producing light on an extensive scale by means of this gas.* He commenced his experiments on this subject in 1792, when he applied it to the lighting of his own house at Redruth, in Cornwall; and afterward to that of the extensive manufactory of Watt and Boulton, at Soho, near Birmingham, on the occasion of the celebration of the peace of Amiens in 1798. But, notwithstanding these successful experiments, and also that several manufactories in Birmingham, Manchester, and other towns were lighted with gas, under the superintendence of Mr. Murdoch, an account of which was published in the transactions of the Royal Society in 1808, so little was

the public in general acquainted with the merits of this invention, that, a few years afterward, Mr. Windsor exhibited the gas light in London as an invention of his own; at least, it was so understood generally; and it was at that time looked upon by most persons merely as a speculation calculated to delude, and not likely to be carried to the extent that was represented. The continual and successful exhibition of this kind of light, however, at the Lyceum Theatre, and in Pall Mall, induced many to inquire into and discuss its merits, and, at last, a company was formed for the purpose of lighting the streets of London. The success of the project is too well known for us to carry its history farther. We shall only observe that, at present, the number of gas lamps for lighting the streets is upward of 168,000, and that above 200,000 chaldrons of coals are annually employed in generating the gas.

749. *Nature of coal gas.* We have already explained that the flame from coals burning in a common fire proceeds from the combustion of the carburetted hydrogen gas that is volatilized and set free; and every one must have observed that, occasionally, jets of flame from some parts of the coal are extremely bright, proceeding from very pure gas. It was natural to imagine that, if this gas could be collected by any means in proper reservoirs, and afterward forced out through small apertures, it might serve, when set on fire, for the purpose of illumination instead of lamps or candles. To effect this, a quantity of coal is introduced into a closed vessel, generally of iron, placed in a proper furnace, by which it is heated so as to throw out the volatile parts, which are conducted, by means of pipes leading from the vessel, to the place where it is to be burned. But as all the products of the coal are not proper for combustion, and some of them are injurious, the gas is first conducted into vessels, where it is purified by several processes. After this it is passed into a recipient called a *gasometer*, from whence it is sent to the various places where it is to supply light. A familiar idea may be formed of this process by a very simple experiment. Put a few bits of good coal into the bowl of a tobacco pipe, and cover the top of it with pipeclay made into a thick paste. When this is dry, introduce the bowl of the tobacco pipe between the bars of the grate into a clear part of the fire, and let it remain till the whole is red hot. Apply now a lighted taper to the end of the stem of the pipe, and a flame will be seen, occasioned by the inflammable gas that issues from the decomposition of the coal. After the whole of the flame has burned out, the bowl will contain only coke.

750. *There are several varieties of inflammable gas.* Pure hydrogen gas, such as is produced by the action of diluted sulphuric acid on filings of iron or zinc, is extremely inflammable; but, though it affords much heat when burning, its flame is too feeble to be employed for artificial illumination. The hydrogen that comes from coal by the above process is united to a quantity of carbon, and is called *carburetted hydrogen*, which burns with a bright white flame. It is supposed that it is the combustion of the carbon that gives out the greatest quantity of light; for the greater the proportion of carbon the greater is the light. There are two varieties of carburetted hydrogen; one having more carbon than the other: that which has the most carbon, called *bi-carburetted hydrogen*, or *olefiant gas*, gives the greatest light; the other is usually termed *light carburetted hydrogen*, and is the same as what rises in bubbles from the mud of marshy places when stirred. The gaseous products from coal consist of a mixture of these, with some others; and a great deal of the beauty of the light obtained from coal depends upon the kind of coal employed, the modes of conducting the process of decomposition in the retorts, and likewise of purifying the gas afterward. It seldom occurs, in domestic economy, that this gas is prepared by an individual for private use; but there are cases, in very large establishments, where this is desirable. We shall describe, in general, the nature of the decomposition of coal for this purpose, as stated by Dr. Ure.

751. "*When coals are heated in a cast-iron retort to ignition*, the progress of decomposition is as follows: First, and before the retort becomes red hot, steam issues along with the atmospheric air. When the retort begins to redden, coal tar distils in considerable quantity, with some combustible gas, of which hydrogen, mixed with ammoniacal gas, forms a part. The evolution of gas increases as the retort becomes hotter, with a continual production of tar and ammoniacal liquor, as well as of sulphureous acid, from the pyrites of the coal, which unites with the ammonia. When the retort has come to a bright cherry-red heat, the disengagement of gas is most active. By-and-by the gaseous production diminishes, and eventually ceases entirely, although the heat be increased. In the retort carbonized coal or coke remains, while tar is found at the bottom of the receiver, covered with the ammoniacal liquor, and combined with carbonic and sulphureous acids, and sulphuretted hydrogen.

"If, during this distillation, the combustible gas be collected and examined at the several stages of the process, it is found to differ extremely in its luminiferous powers. That which comes off before the retort has acquired its proper temperature gives a feeble light, and resembles the gas obtained by the ignition of moist charcoal, consisting chiefly of hydrogen. That evolved when the retort has just acquired throughout a vivid red heat is the best of all, consisting chiefly of bi-carburetted hydrogen, or olefiant

gas. From good coal it consists, for example, in 100 measures, of 13 of olefiant gas, 82·5 of carburetted hydrogen, 11·0 of carbonic oxyde, 1·3 of azote; the mixture having a specific gravity of 0·650. At a later period, as after five hours, it contains 7 measures of olefiant gas, 56 of carburetted hydrogen, 11 of carbonic oxyde, 21·3 of hydrogen, 4·7 of azote; the specific gravity of the whole being 0·500. Towards the end of the operation, as after ten hours, it contains 20 measures of carburetted hydrogen, 10 of carbonic oxyde, 60 of hydrogen, 10 of azote, with a specific gravity of only 0·345. The hydrogen becomes sulphuretted hydrogen, if there be much iron pyrites in the coal. The larger proportion of the gas is disengaged during the first hour, amounting to about $\frac{1}{5}$ of the whole; in the three following hours the disengagement is tolerably uniform, constituting in all $\frac{54}{100}$; in the sixth hour it is $\frac{1}{10}$; in the seventh and eighth hours $\frac{16}{100}$."

752. "*From these observations are derived the rules for the production of a good light gas from coals.* They show that the distillation should commence with a retort previously heated to a cherry red, since thereby good gas is immediately produced, and a portion of the tar is also converted into gas, instead of being simply distilled over into the condenser pit; that this heat should be steadily continued during the whole operation—from five to eight hours; that it should not be increased, especially towards the end, for fear of generating carbonic oxyde and hydrogen gases, as well as of injuring the retort when the cooling agency of gasification has become feeble; and that the operation should be stopped some time before the gas ceases to come over, lest gases with feeble illuminating power should impoverish the contents of the gasometer. Upon the average, a pound of good coal affords four cubic feet of gas, more or less, according to the force of the retort, and the manner of firing it."

753. *The gas as it comes from the retort is not, at first, adapted for the purpose it is designed to answer*, as it is easy to see from the above statement. It must be carefully freed from the tar and ammonia, and also from carbonic acid and sulphuretted hydrogen gases; the presence of which, especially the latter, would be highly injurious. Hence the purification of the gas demands the utmost vigilance on the part of those who superintend gas-works, and is the part of gas-making with which the public is chiefly concerned: an ill-conducted gas-work affords not only an imperfect light, but emits offensive and deleterious effluvia.

754. *The process of purification* is somewhat differently conducted in different works. In very large establishments, the gas is made to pass through a mixture of lime and water, which is kept in constant agitation. This limewater absorbs the ammonia, carbonic acid, and sulphuretted hydrogen. In smaller works, purification is sometimes effected by forcing the gas through successive layers of fresh-slacked lime. The purer the gas, the lighter it becomes; hence the specific gravity is considered as a test of its purity.

755. *There is much difference in the quality of coal for affording gas.* The most bituminous or caking coal is generally best; and the Newcastle coal is much employed; but the cannel coal yields the most gas. The sulphuretted hydrogen in coal gas, which is so injurious, proceeds from the sulphuret of iron, or iron pyrites, of which almost all coal contains a portion, more or less. The coke, which remains in the retorts after the gas has been extracted, is employed as fuel for domestic and other purposes.

756. *It is surprising to see with what facility and neatness gas lights are now managed.* The gas, being collected in a purified state in the reservoir or gasometer, is conveyed by tubes, which branch out into smaller ramifications, until they terminate at the places where the lights are wanted. The extremities of the branching tubes are furnished with burners having small apertures, out of which the gas issues with a velocity corresponding to its degree of pressure. Near the termination of each tube there is a stop-cock, upon turning which, when light is required, the gas instantly flows in an equable stream, and instantly inflames, on the approach of a lighted taper, into a brilliant, soft, and beautiful flame, requiring no trimming or snuffing to keep up equal brightness; and the quantity of gas that issues, and, of course, the height of the flame, is regulated simply by turning the stop-cock: it may be made to give a considerable flame, or one so low and dim as scarcely to be perceived.

757. *The gasometer*, into which the gas is collected in the gas-works, previously to its being sent out in pipes to be burned, is not merely a magazine for receiving it, and keeping it in store for use, but it is likewise necessary for communicating to the gas, in the act of burning, such a uniform pressure as may secure a steady, unflickering flame. It consists of a large cylindrical vessel, inverted, or with the open end downward, in a cistern of water, the gas being sent through the water into it: a pipe leads from it; and the pressure applied to force the gas out is regulated by weights attached to the gasometer.

758. *The construction of the burners*, or the mode of burning the gas as it issues from the jets, has a great influence upon the quantity and quality of its light. Originally it was only a simple beak perforated; and these are still employed in butchers' and other

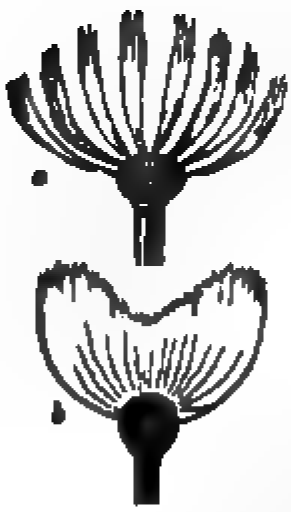

Fig 148.

shops of a similar kind, where the gas burns outside the house; but these generally give much smoke. A more elegant mode is to divide the flame into three or more small jets in fanciful forms, protected by glasses, which form splendid substitutes for oil lamps in streets, and some other places, *fig* 148, *a*. In this way, when the gas is well purified, there is scarcely any smoke, on the principle we explained when treating of lamps, that several small flames produced a more perfect combustion than one thick flame. Another kind of burner is called a "bat's wing," *b*, *fig* 148; this is a thin sheet of flame issuing from a narrow aperture between two plates of metal: for the same reason this flame has little or no smoke.

759. *But when the gas lights are burned in the interior of apartments and shops*, where the smoke is to be entirely destroyed, the usual method is to make the gas issue through a circle of very small pinholes near each other, by which all the small flames unite together to form a circular flame, like an Argand lamp, and, at the same time, a column of air rises through the centre of this flame, as is seen in *fig*. 149, which represents the perspective view and section of one of these burners. The ornamented stage on this burner supports a cylindrical glass, which prevents the flame from flickering with the wind; but it has little effect in destroying the smoke. When a very strong light is required, causing, of course, a greater consumption of gas, it is proper to use glasses contracted in the manner shown when treating on lamps, that cause the current of air to impinge upon the flame. This kind of glass is the more necessary for oil gas, on account of the quantity of carbon which it contains, which, if unburned, would occasion smoke. The pinholes should be exactly of equal size, otherwise the light will burn like a badly-trimmed Argand lamp. The height of the flame is regulated by turning the stop-cock on the pipe.

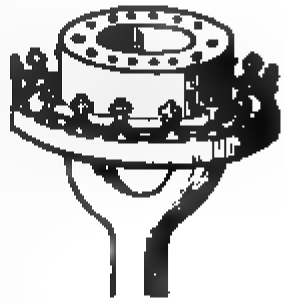

Fig. 149.

Fig 150 exhibits the usual manner in which two gas burners are suspended, or, rather, appear as if suspended; here the gas is supplied to the burners by a tube in the centre, from which branches proceed furnished with stop-cocks. An infinite variety of other designs are employed; and some closely resembling the forms of elegant chandeliers are introduced.

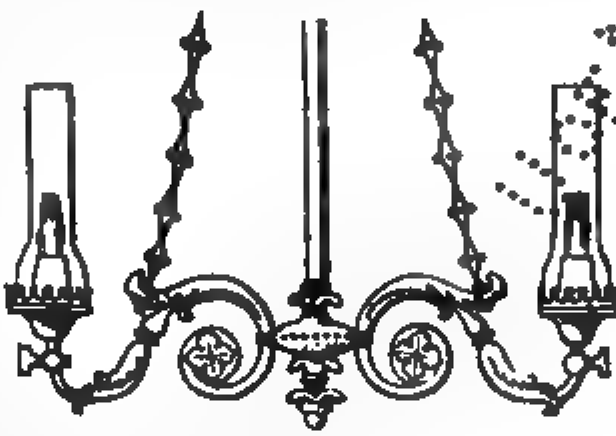

Fig. 150.

760 *In a gas flame, as in that of a candle*, it may be observed that the bottom of the flame is blue; because, as it issues with great velocity, the gas gets mixed with a large quantity of atmospherical air, and the hydrogen is consumed too rapidly for the carbonaceous part to be burned also; the flame of hydrogen alone being blue; but, higher up, the flame becomes white, because it is there the carbon is consumed, which produces the whiteness and luminous property of the flame.

761. *The various other products of coal, when distilled, besides the gas, are turned to some account.* From the ammoniacal liquor muriate of ammonia is made. 200 lbs. of coal afford 17 lbs. of coal tar, which again contains in 100 lbs. 26 lbs. of coal oil, and 48 lbs. of pitch. The tar is employed as a paint to preserve wood, but its smell is disagreeable. The pitch may be used for some of the purposes answered by common pitch, though it is inferior.

762. *Coal oil*, procured by the distillation of coal tar, mixed with an equal bulk of water, may be used as a fuel under a boiler. The mixture is made to boil in a kettle, and the mingled vapours of the oil and the water, when passed through a perforated nozzle, are kindled, and give a great heat; the water is thought to be in part decomposed. Coal oil, rectified by distillation, is extensively employed for dissolving caoutchouc in making the varnish of waterproof cloth, and also for burning in peculiar kinds of lamps, under the improper name of naphtha.

763. *Portable gas.* The inconvenience of being obliged to have the lights fixed in the ordinary way of employing it gave rise to the contrivance of portable gas, which was the invention of Mr. Gordon. To make these lights portable, the gas is forcibly com-

members, was drawn to the subject of ventilating lamp-burners in houses, and he was induced to suggest the trial of various plans for effecting the removal of the products of combustion produced by sources of artificial light. All substances used for the purpose of illumination may be represented by oil and coal gas; although tallow and wax are also greatly employed, yet, as, until rendered fluid, like oil, they cannot be burned, for all practical purposes they may be classed with it. Oil and gas both contain carbon and hydrogen; and it is by the combination of these elements with the oxygen of the air that light is evolved. The carbon produces carbonic acid, which is deleterious in its nature, and oppressive in its action in closed apartments, and the hydrogen produces water. A pound of oil contains about 0·12 of a pound of hydrogen, 0·78 of carbon, and 0·1 of oxygen; when burned, it produces 1·06 of water, and 2·86 of carbonic acid, and the oxygen it takes from the atmosphere is equal to that contained in 13·27 cubic feet of air. A pound of London coal gas contains, on an average, 0·3 of hydrogen, and 0·7 of carbon; it produces, when burned, 2·07 of water, and 2·56 of carbonic acid gas; consumes 4·26 cubic feet of oxygen, equal to the quantity contained in 19·3 cubical feet of air. A pint of oil, when burned, produces a pint and a quarter of water, and a pound of gas more than two and a half pounds of water; the increase of weight being due to the absorption of oxygen from the atmosphere, one part of hydrogen taking eight by weight of oxygen to form water. A London Argand gas lamp, in a closed shop window, will produce, in four hours, two pints and a half of water, to condense or not upon the glass or the goods, according to circumstances. A pound of oil also produces nearly three pounds of carbonic acid, and a pound of gas two and a half pounds of carbonic acid. For every cubical foot of gas burned rather more than a cubical foot of carbonic acid is produced. Now, carbonic acid is a deadly poison: an atmosphere containing even one tenth of it is soon fatal to animal life. The various accidents from lime and brick kilns, brewers' vats, occasionally from the sinking of wells, as at Cheltenham, and from the choke damp in coal mines, attest the extreme danger contingent upon the presence of this substance. A man breathing in an atmosphere containing seven or eight parts of carbonic acid would suffer, not from any deficiency of oxygen, but from the deleterious action of the carbonic acid. M. Leblanc has recently analyzed carefully the confined air of inhabited places, and concludes, as stated in his memoir, that the proportion of carbonic acid gas in such places may be regarded as measuring, with sufficient exactness, the insalubrity of the air; that, in the proportion of 1 part to 100 of air, ventilation is indispensable for the prevention of injury to the health; that the proportion of carbonic acid gas had better not exceed a five-hundredth part, though it may rise without inconvenience to a two-hundredth part. If a room, twelve feet square and twelve feet high, with the doors, windows, and fireplace closed, has a gas lamp burning in it, consuming five cubic feet of gas per hour, the light will produce sufficient carbonic acid, in rather more than three hours, to be in the proportion of 1 part to 100 of air, and, as M. Leblanc states, when in such condition, the air is decidedly injurious to health; and even in one hour and a half it will produce that proportion of carbonic acid which he considers should never be exceeded. If a lighted taper be applied to the top of a lamp chimney, it will be instantly extinguished, or a glass jar held over it will become immediately filled with air in which a light cannot burn, nor can any animal live in it. Or, if a portion of limewater be poured into the jar, it will become turbid in appearance, owing to the precipitation of the carbonate of lime, formed by the combination of the carbonic acid with the lime. Sulphureous and sulphuric acid are also contained in the water, which results from the combustion of coal gas, and are products injurious to metals and articles of furniture.

"It will now be understood that the object sought to be attained in the ventilation of lamp-burners is the entire removal of all the noxious products of combustion; and, with this view, at Professor Faraday's suggestion, the gas lights of the chandelier in the library at the Athenæum were ventilated by pipes dipping into the lamp glasses, and conjoining, at a short distance upward, into one central pipe, which carried away all the burned air out of the room, *fig.* 152. In this first practical experiment many things were learned as to the mode of arranging the pipes; the disposal, when the pipes were very long, of the water produced, &c., &c.; but the objects sought for by the ventilation were at once and perfectly obtained. This principle may be illustrated by a simple experiment, showing the difference between allowing combustion to give its products to the air of a room, and carrying off these products, as soon as found, to the exterior. Let a short wax candle be placed, burning, on a plate, a glass jar put over it, and the upper aperture of the jar closed by a globular cork, through which passes a piece of glass tube, about half an inch in diameter, and twelve or fourteen inches long; the tube descending to the top of the candle flame, and being placed just

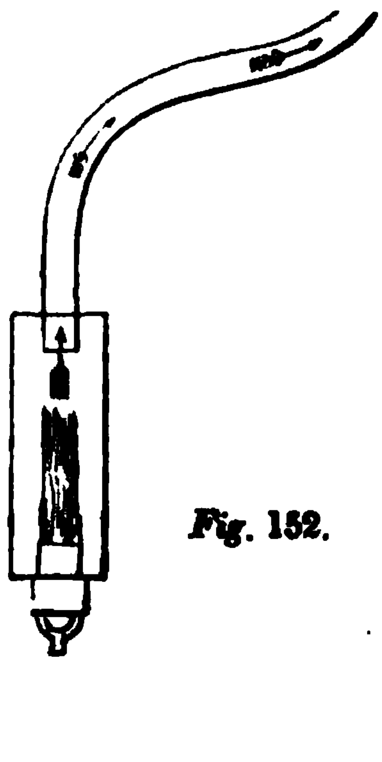

Fig. 152.

above it. Under these circumstances, there will be plenty of air passing into the jar between it and the plate, and out by the tube, to supply all that is needed for combustion, and keep the glass chamber sweet: the consequence is, that, in this position, it will go on burning for any length of time, and the jar remain quite clear and bright. But, on moving the cork a little, so that the tube shall no longer be over the flame, all these results will change, though the airway remains exactly as before. The candle will now give the products of its combustion to the general air of the glass chamber, which immediately becomes dull, from water deposited upon it; the air itself will become worse and worse, the light dim, and in a few minutes will go out; but if prevented, by the tube being again placed over it, signs of recovery will appear, the light will resume its former brightness, and, after a short time, even the dew will disappear from the glass, and all this in consequence of the proper ventilation of the light. These effects, though striking, may easily be understood by any one who will think of the difference of lighting a fire in the middle of a room, instead of under, or in right juxtaposition to a chimney.

"Then came the desire of modifying the system, by removing the ascending flue from its place over the lamp, not from any deficiency in action, but for appearance sake only; and finding that there was sufficient ascension power in the main part of the metal chimney to allow of a descending draught over the lamp, the tube, in place of going directly upward, was made to turn short over the edge of the glass, to descend to the arm or bracket, to pass along it, and then ascend at the central part of the chandelier, or against the wall, if applied to a single light. To this succeeded another form, which is exceedingly beautiful, and appears to be the perfection of lamp ventilation. It is, in fact, a beautiful application of the principle of a descending draught to a lamp-burner. The gas light has its glass chimney, as usual, but the glass-holder is so constructed as to sustain not merely the chimney, but an outer cylinder of glass, larger and taller than the first; the glass-holder has an aperture in it, connected by a mouthpiece with a metal tube which serves as a ventilating flue, and which, after passing horizontally to the centre of the chandelier, there ascends to produce draught and carry off the burned air.

"*Fig.* 153, *a*, is the burner; *b*, the gas pipe leading to the burner; *c*, the glass holder, with an aperture in it, opening into the mouthpiece *d*, which is attached to the metal chimney; *e*, the ordinary glass chimney; *f*, an outer cylinder of glass, closed at the top by a plate of mica, *g*; or, still better, by two plates of mica, one resting on the top of the glass, and the other one, *h*, dropping a short way into it. They are connected together by a metal screw and nut, which also keeps them a little apart from each other; thus forming a stopper, which cannot be shaken off the glass chimney, but is easily lifted on and off by the small metal ring or knob at the top; *i* is the metallic tube chimney; *k*, a ground globe, which may be applied to the lamp, and which has no opening, except the hole at the bottom, where it rests on the glass-holder: but any other form, as a lotus glass or vase, may be substituted at pleasure.

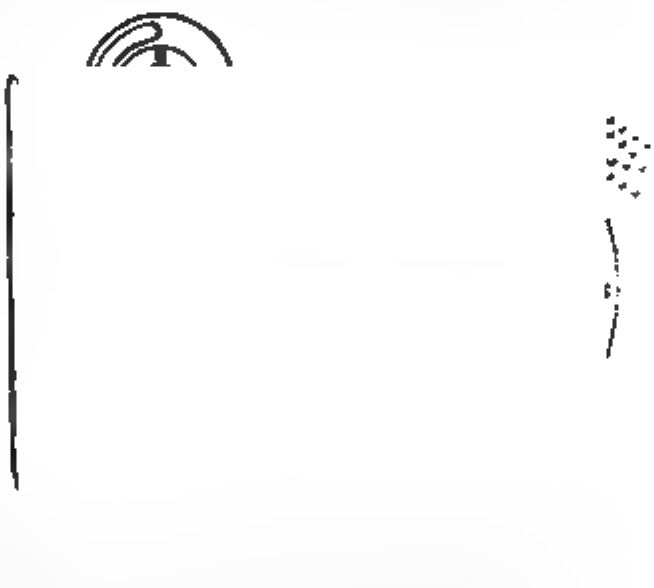

Fig. 153.

"A, *fig.* 153, is a plan of the glass-holder, showing the burner, *a*, in the centre, perforated with jets, with openings round it to allow of a free admission of air to the flame; and the aperture, *d*, which opens into the mouthpiece connected with the metal chimney, *i*.

"The burned air and results of combustion take the course indicated by the arrows, and are entirely carried away by the chimney.

"Now, with a lamp burning in the ordinary way, the products of combustion issue out as a torrent of aerial impurity from above; but, if the above arrangement be applied, on closing the top of the outer glass cylinder by a plate of mica, all the soot, water, carbonic acid, sulphureous and sulphuric acid, and a portion of the heat, are entirely carried away by the aerial sewerage, and discharged into a chimney or the open air; and the air in rooms may thus be kept in the same sweet and wholesome condition, and as fit for the purposes of respiration, as if artificial light were not being used.

"A curious but important result of the enclosed lamp is the increase of light produced, amounting to from 10 to 20 per cent., according to circumstances, the same quantity of gas being consumed as before. If the current of air through a lamp glass, when the gas is burning in the usual manner, be diminished, the flame rises in height, and the light is increased in amount; the combustion, in fact, is not so intense, be-

cause the access of air is retarded, the particles of carbon which give the light are not so highly ignited, but are more abundant, and are ignited for *a longer time*, thereby causing an increase of light.

"The advantages of this invention are many: it is not objectionable in architectural appearance; the ventilation is perfect; the heat given to a room is modified and pleasant, and may be either sustained or diminished at pleasure; the light, for good philosophical reasons, is increased considerably for a given portion of gas; and additional safety from accidents is obtained, as, in the event of any leakage from the pipes, or from a gas-cock being inadvertently left open, the gas, instead of mixing with the air of the room and becoming explosive, would almost inevitably be carried off by the metal tubes.

"Mr. Professor Faraday has transferred his right to this invention to his brother, Mr. Robert Faraday, 114 Wardour-street, Soho, who has secured it by a patent."

It is to be observed that this ingenious method is chiefly applicable to gas lights, where the products of combustion can be carried off by a pipe that goes parallel to that which supplies the gas. To adapt it to suspended oil lamps, there must be a tube reaching from the lamp to the ceiling, into which the separate tubes from each burner shall unite; and then a method of discharging the noxious gas from the top of the tube at the ceiling into the open air.

The same effect has been attempted by having funnels with tubes over each light, *fig.* 154; but this is not found to answer, because so much common atmospheric air enters the funnel, together with the burned air, that the draught is not found sufficient.

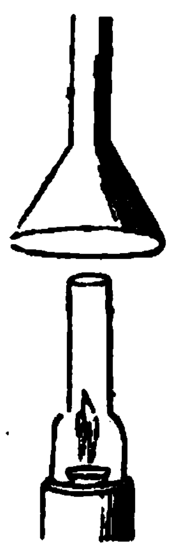

Fig. 154.

777. *It is proper to be known that coal gas mixed with common air will explode like gunpowder*, when a light of any kind is brought into it. Hydrogen by itself, or carburetted hydrogen alone, only burns; but when mixed with a certain proportion of atmospheric air, it explodes when brought into contact with a burning body. The danger is evident of suffering this gas to escape from the pipes, or any other part, into an apartment. When the quantity that escapes is but small, it may be discovered by its peculiar smell, and there may be yet no real danger; but when the quantity becomes considerable, it forms with the common air an explosive mixture. Several accidents have happened through the escape of the gas in this manner, in consequence of which persons have lost their lives, or have been severely wounded; and the premises have been sometimes destroyed by the explosion. This accident is of the same nature, on a small scale, as what we hear of in coal mines, where, from the issuing of the carburetted hydrogen from the coal strata, explosions sometimes destroy thirty or forty people. Whenever it is suspected, therefore, that gas may have escaped into a room, it is imprudent to enter it with a lighted candle, without first ventilating it by some means. Fortunately, the smell of the gas gives warning of its escape.

Notwithstanding this evident danger, it is surprising how few serious accidents have occurred in the employment of gas for lighting. Still it is proper that every one should be fully aware of the risk that is incurred by neglect.

778. *Coal gas has sometimes the effect of turning white oil paint black*, owing to the sulphuretted hydrogen contained in the gas. This may be prevented, in a great measure, by varnishing the paint, which will protect the white lead from the action of the gas. The same effect is not produced upon any part coloured by whiting: it being the *oxyde of lead* alone that is changed in colour.

779. *The laying on of the gas pipes in a proper manner* is essential in this species of illumination, and demands much experience and skill in this kind of work: hence it is now executed by a particular class of artisans, termed *gas fitters*. It is not safe to employ pipes of pewter, lead, or tin, as their softness would render them liable to serious accidents: copper or iron pipes alone should be used. Before the pipes are fixed, they are proved by a condensing hand pump in water, and likewise after they are fixed by a condensing syringe, and a lighted taper carried along the pipe.

780. *The gas for lighting has been prepared in private establishments*, but the apparatus for this purpose is expensive; and the preparation of the gas and purification demands considerable scientific knowledge, without which it would be unwise, and indeed unsafe, to attempt it. We do not consider it necessary, therefore, to describe the apparatus that would be requisite for that purpose, since those who intend to make gas for themselves must apply to more extensive sources of information than can be expected in a work like the present.

BOOK V.

ON HOUSEHOLD FURNITURE.

CHAPTER I.

GENERAL OBSERVATIONS.

781. *The term furniture* includes all the articles, for common use and ornament, required in an inhabited house, and may be classed in various ways. They are divided into *fixtures* and *moveables*; the first, being fixed to some part of the building, cannot be easily removed without injuring it, or causing great inconvenience; they consequently remain attached to the house on every change of inhabitant, the new tenant paying the value; or they become the property of the landlord, as may be agreed upon. A list of the fixtures is inserted in every lease. Furniture may likewise be classed according to their several kinds and uses, as tables, chairs, &c.; or according to the apartments in which they are placed, as parlour, bedroom, nursery, &c., furniture. We may likewise arrange them according to the several trades by which they are prepared, as joiner's work, cabinet work, upholstery, ironmongery, glass, pottery, &c. We shall not adopt exclusively either of these modes of classification, but describe the articles as their connexion with each other may seem to require.

782. Before we proceed to describe in detail the several articles of furniture in common use, it will be proper to say something of the several trades by which they are produced, and also of the materials usually employed in their manufacture.

CHAPTER II.

CABINET-MAKER AND UPHOLSTERER.

783. *The household furniture that comes under the class of fixtures*, such as kitchen dressers, shelves, closets, sinks, &c., are made by the joiner in finishing the house; but the moveable furniture of wood work is chiefly executed by the cabinet-maker and upholsterer. As these are the most important trades in the furnishing a house, some hints respecting them may be useful to their employers; but it is not our intention to enter so much into the subject as to attempt the instruction of those who practise these several arts.

784. *The business of the cabinet-maker* is, in strictness, different from that of the upholsterer: the former being a superior kind of joiner, but who, instead of being employed, like the joiner, in executing the parts of the building itself, is occupied with the nicer kinds of furniture made of the finer woods, such as tables, sideboards, chairs, sofas, cabinets of all kinds, &c. The upholsterer is concerned with certain articles of furniture that do not belong to this class, as beds and everything belonging to them, carpets, floor cloths, window curtains, &c. But these trades are necessarily so connected in many parts that, as far as the public is concerned, the cabinet-maker and upholsterer are now often united in the same person. The upholsterer, indeed, seldom himself manufactures the furniture he sells, but gets the several articles made by persons who, from the subdivision of labour, confine themselves to particular branches: thus there are chair-makers, bedstead-makers, bed and mattrass makers, cabinet-makers who make tables, sideboards, wardrobes, and other things altogether of wood, &c. A few cabinet-makers and upholsterers, indeed, who are in a large way of business, sometimes employ work-people on their own premises in their several departments, and can thus assure themselves that the articles they undertake to have executed can be depended upon for materials and workmanship; and for this advantage, which requires considerable superintendence, the public pays, with justice, a higher price. Of the practical skill of our best mechanics in executing the several articles of cabinet-making, as far as strength and excellence of work are concerned, it is sufficient for us to say, that it is not excelled in any part of the world. Before we proceed to the description of the various materials of which furniture is made, we shall take notice of such of the processes in these branches of art as are necessary to be generally known.

785. *All the parts of some furniture are made out of solid wood*, and it is very important that this should have been thoroughly dried, or, as it is termed, *seasoned*; wood not well seasoned is apt to warp, and the work will sometimes come to pieces, or cause defects not easily remedied; and here appears the superiority of manufacturers who have sufficient capital to keep materials long enough on their own premises to ensure their being completely seasoned.

786. *Wood is sawed into logs or into planks* in the countries where it grows; and it is

subdivided here into the sizes requisite for different kinds of work; for which purpose steam machinery is occasionally employed in a few of the large workshops: circular saws are used for this purpose.

787. *When wood is required of curved forms* in cabinet work, it is generally cut out of the solid, which is very expensive, particularly when the wood is of a rare kind; but in this department, as well as in joinery, wood is occasionally bent by first softening it with steam, then bending it into the required form, and fixing it there by drying. This method has been practised from time immemorial in Russia, where it has been applied even to making cart-wheels.

788. *The veneering of furniture* is employed to obtain a very beautiful wood at less expense. The choicest specimens of mahogany are considered too valuable to be wrought up in a solid state, and are therefore sawn into thin leaves or slices, called *veneers*, which are fixed with glue as facings, either on mahogany of a coarser kind, or to oak or other hard woods. By these means this beautiful substance may be made to cover a great extent of surface; and the parts, by judicious management, may be so united as to appear like one entire piece. As the operation of veneering requires great skill, and is sometimes apt to fail or be imperfect, veneered furniture is not so much to be depended upon as that which is made of solid wood. Such furniture requires more care; it should be kept in dry situations, and, after having been exposed to damp, should not be placed too near a fire, as it is apt to warp. If the veneering has not been well executed, or the ground beneath is improper, the veneer will sometimes blister or come off. Deal is sometimes used to veneer upon, but it is a bad material: upon the whole, however, the veneering of furniture is a great improvement, on account of the economical use of fine specimens of wood. Formerly these veneers were cut by the pit or hand saw, but at present they are cut with much greater accuracy, as well as expedition, by large circular saws having a very thin blade, which cut twelve veneers out of a board one inch thick.

789. *Furniture is sometimes executed entirely of a single kind of wood*, as oak, mahogany, rosewood, ebony, &c., and sometimes several species of wood are used in the same article. The first is, generally, the best taste, and particularly when it is ornamented by carving: occasionally the tops of round tables are made of various pieces of the same kind of wood, so skilfully joined that the lines of junction are not to be traced without the closest inspection, or by means of the pattern produced by the different direction of the grain. Nothing can exceed the beauty of some modern English tables of this kind, made of native as well as foreign woods; and, upon the whole, we can safely recommend these as some of the most beautiful kinds of furniture.

790. *Staining wood*, in imitation of a few of the more expensive kinds, such as rosewood, is now so successfully performed, that it can scarcely be distinguished from the original wood; and although this stain is not perfectly durable, yet it is sufficient for a number of ordinary purposes: of course, the difference in price between real and stained wood is very great.

791. *Inlaying* is a mode of ornamenting furniture resorted to by those who are not content with the natural beauty of wood, or where a certain richness and gayety is proper. When this inlaying is done with various kinds of wood, it is called *marquetry*; when inlaid with brass or tortoise-shell, it is termed *buhl*. On these we shall make a few observations.

792. *Marquetry* is in wood what mosaic is in stone; pieces of various woods, or those which have been stained for the purpose, being put together. The art is very ancient, and was formerly held in great esteem. Some of the oldest specimens are executed only in black and white, and are termed *morescoes*; and it is said that the first who employed a great variety of colours was John of Verona, who was contemporary with Raphael. He stained his woods with various colours, and invented the method of producing shadows on them by burning one edge. The art was much cultivated among the French in the seventeenth century, and may frequently be observed in furniture of that period. A design being made, the forms in it are cut out of the wood to be ornamented, and woods of various kinds, or stained wood, suitable for the various parts of the design, are selected, cut to the proper shape, and fixed in with glue. The woods are now cut into thin veneers, not above the thickness of the twelfth part of an inch, and afterward sawed into the various shapes according to the design. Three or four pieces are usually sawed out together, if possible, on account of the thinness of the stuff; after they are glued down, the whole is put into a press to dry, planed over, polished, and varnished. It is obvious that the utmost nicety in joining the several pieces is essential. Marquetry is sometimes confined to simple forms, as squares, lozenges, &c., as in the floors of apartments; but all kinds of subjects have been occasionally represented on furniture. Some, however, as, for example, landscapes, are obviously so difficult, from the nature of the process, that, success being impossible, they had better never be attempted. For certain kinds of ornaments, marquetry has a pleasing effect. In fruit and flowers the art, as usually executed, appears generally more curious than beautiful; and the expense is greater than it deserves. Some specimens of

the best French marquetry are valued as the furniture and style of a certain period, and we believe that none executed in our shops at present comes quite up to them, although occasionally pretty specimens are produced.

An extremely elegant kind of marquetry is sometimes seen, consisting of tolerably large figures in satinwood, having the internal lines drawn in umber, and the whole let into mahogany. In this art there is a considerable field for invention and improvement.

793. *The staining of wood for inlaying* is effected as follows: A bright red stain is produced by a strong infusion of Brazil wood in water impregnated with pearlash: a red less bright is made by a solution of dragon's blood in spirits of wine, and a pink colour by the Brazil wood stain diluted: a yellow stain is made with the tincture of turmeric or French berries. an orange with dragon's blood and turmeric. Blue is obtained by indigo, or by a solution of copper in aquafortis. Green is made by verdigris dissolved in vinegar. Purple by a decoction of logwood and Brazil wood. Black, by brushing the wood first with a solution of sulphate of iron, and then with an infusion of gall nuts. The woods to be stained must be white.

794. *Buhl*, or inlaying cabinet work with ornaments of brass or tortoise-shell, *fig.* 155, is said to have been the invention of a German of that name; or as it was first practised in a town of Germany so called. It consists of a complicated kind of light ornament let into grooves of ebony or some dark wood. When tortoise-shell is used, it is usually laid upon a red ground, which appears through the transparent part of the shell. Sometimes the pattern in brass is let into a ground of tortoise-shell, and sometimes tortoise-shell is let into brass: the figures of both are cut with a fine saw together, so that one fits into the other without any difficulty. A good deal of buhl is imported on foreign furniture; but it is too expensive to be much practised in this country, although it is made occasionally to decorate small articles. Rosewood inlaid with buhl may be cleaned, when the brass has become dull, by rubbing it with tripoli or rotten stone and a very little sweet oil.

Fig. 155

795. *Mosaic* work consists of an assemblage of little rectangular pieces of marble, precious stones, or glass, arranged so as to represent a picture when fixed upon a ground of stucco by means of a cement.

Among the ancients, mosaic appears to have been confined to pavements, for which it is admirably adapted; since, notwithstanding its being frequently trodden upon and washed, it is not injured.

Of modern mosaics, some of the most celebrated are the works of Joseph Pino, and the Chevalier Lanfrano, in the Church of St. Peter, at Rome; also some at Pisa, Florence, and other Italian cities. There is also some good mosaic in the chapel at Versailles. Extremely minute mosaics are sometimes brought from Italy.

796. The *Pietra dura*, brought from Florence, is a sort of mosaic; but, instead of the stones being cut into little squares, they are cut into the forms of the objects represented, like marquetry. We can say nothing for the beauty of the art; for, whatever ingenuity may be employed in it, the effect of imitation is very incomplete, at least in the subjects usually attempted.

797. *Carving*. In a great part of our best furniture there is more or less carving. The art of carving in wood is so ancient, that, probably, the first attempts at sculpture were in that material. Not long since, among the uncivilised South Sea Islanders, very curious specimens of carving on their canoes were seen, executed without the use of iron tools. We find carving in cedar mentioned among the arts of the Israelites, and some of the earliest statues of the Greeks were in wood as well as marble. In modern times, carving in wood was practised to a great extent in Italy, Germany, and the Netherlands. In Germany, more than in any other country, a taste for sculpture in wood prevailed, which, indeed, partly exists at the present day. Not only are their churches richly decorated with exquisite carving, to be seen in the pulpits, stalls, and confessionals, but the ancient chateaux of the nobility, and even the residences of the wealthy citizens, can boast of fine specimens of wood carving. In Holland and Belgium the same may be observed. The finest examples of this art appear to have been executed between the twelfth and seventeenth centuries. In this country, it is evident, from our churches and mansions, that our ancestors endeavoured to keep pace with their continental neighbours in the arts of sculpture in wood; and down to a late period, admirable carvings of this kind were executed, as may be seen by the exquisite performances of Grinlin Gibbons, in St. Paul's and other places, in the reign of Charles II. Gibbons died in 1703, and was the last of our native carvers who arrived at eminence. After the time of Gibbons, the art declined in this country from various causes, and until very lately had become nearly extinct, owing, in a great measure, to the introduction of composition and paper-mâché ornaments, which, being moulded and glued

on to wood, answered so many of the purposes of the carver's art as to destroy entirely his practice. These substitutes are still largely employed, particularly in picture frames, ceilings, cornices, and other parts where enrichments are required; but for some years past, carving has been again encouraged to a certain degree, and is now making some progress, chiefly from the style of the time of Louis XIV. getting into fashion, the ornaments of which being in a style of great boldness, it is necessary to resort to carving in many cases.

798. *Castors* are the small wheels fixed to the feet of such heavy furniture as are required to be moved frequently, as tables, sofas, &c.; and they are, in consequence of the weight upon them, peculiarly liable to be out of order, yet sometimes a little care may put them to rights: it is useful, therefore, to understand their construction. *a*, *fig*. 156, is a castor of the common kind: it has a brass socket, which is driven on the end of the leg, which is cut round to fit it: on the bottom of this socket there is an iron plate, in which is riveted an iron pin, on which the brass shank, *b*, carrying the brass wheel, turns. *c* represents a castor upon an improved construction: to lessen the friction of the shank, which is considerable, it turns against three little balls which are moveable in the interior of the socket: this causes the shank to revolve with much greater freedom, and allowing the wheels to act with greater certainty by presenting their faces always in the direction of the motion required: except they do this, castors are of no use. There are other improved castors: and it is worth while, in most cases, to have the best, the common ones wearing out too soon.

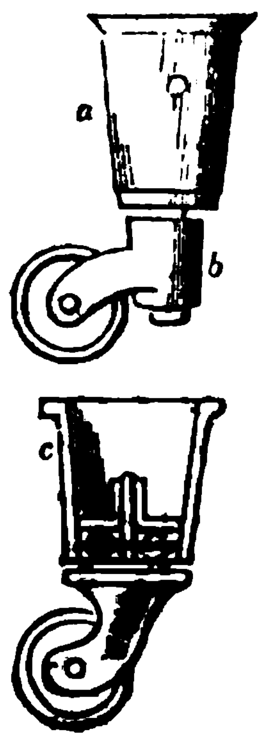

Fig. 156.

799. *When cabinet work is finished*, it is well rubbed with fine sand-paper, to smooth it, and afterward dusted: it is then polished. Three principal kinds of polish are used: wax polish, oil polish, and French polish.

800. *Wax polish*. This is the most ordinary kind of polish, where it is desirable not to darken the colour of the wood; but it is not good for table tops, or many other parts of furniture, as it is apt to leave a degree of clamminess that causes every touch of the hand to leave a mark; and water spilled upon it tarnishes the lustre, which it requires hard rubbing to restore. Nevertheless, it answers sufficiently for many general purposes. It is applied in the following manner:

To four ounces of bees' wax scraped fine, add one ounce of black rosin pounded very fine, and on these pour oil of turpentine sufficient to dissolve them, so that the solution shall be of the consistence of cream. Suffer this to remain for twenty-four hours, till the whole is completely dissolved. Apply this solution, with a clean linen rag, to the cabinet work, until the whole wood is covered. After the liquid is absorbed by the wood, rub the latter hard with a roll made of baize, and afterward with soft woollen cloths, taking care that no part shall be left clammy, and also taking great care that no dust or dirt attach to the work to occasion scratches. Repeat this in a few days, or a week; if any more of the solution be necessary, add some, but the less of the solution that is used to get the work to shine, and the more rubbing is employed, the better.

801. *Oil polish*. This is the best polish for the tops of dining tables. It is prepared and executed as follows: Before the application of the polish, clean the table top by washing it with oil of turpentine, so as completely to eradicate any stains of grease that may be on it: then clean this well off by linen cloths. Dip a brush similar to the medium-sized painter's brushes, or a piece of linen cloth, into some of the best cold-drawn linseed oil, and apply it to every part of the table top, or other article of furniture. Let the oil remain on for six or twelve hours, or more, taking care to guard it from dust. Then rub it with a clean woollen cloth for an hour or more. As soon as it appears perfectly clean and dry, apply linen rubbers, to remove any moisture that may be left on the surface. In three or four days repeat the application of oil, as before; and when this operation has been performed about four times, before the oil is again applied, take a sponge with water blood warm, and wash the table-top all over: wipe it quickly, and dry it with linen cloths, to extract all dirt. The oil will have saturated the wood sufficiently to have prevented the water from penetrating. The lustre may not come out so soon as may be expected; but, by perseverance for a month, or perhaps two or three, the labour will be amply compensated by the result. The polish will be brilliant and lasting: it will bid defiance to stains from hot dishes, fruits, boiling water, and other liquids, and may be kept to its maximum of lustre with a very slight proportion of regular labour. Some persons have recommended the use of alkanet root and rose pink with the oil: this gives a rich reddish hue when the wood is too light; but the effect of these ingredients is to darken and to destroy the beautifully-variegated shades in good mahogany. Even with the oil alone, the wood will become darker than with wax, as in the last receipt: but after it has come to its proper polish it will change very little. This polish must not be used for rosewood, as it would render it too dark.

802. *French polish.* This most beautiful varnish for furniture derives its name from its having been invented in France some years ago; but it is now universally used in this country. Although it may be applied by any one who will take the trouble of learning how to use it, this is not necessary now, nor worth the while, since French polish has become a distinct trade; and, as it requires considerable practice to execute it properly, it is cheaper and better to employ those who are already familiar with the process. We therefore give the receipt for it merely to explain its nature, without recommending any one to depend upon themselves for its application. With a brilliancy superior to any other polish that can be given to furniture, it is not so easily scratched as the other polishes, and is not marked by hot things placed upon it; but wine destroys it, and any liquid containing spirit, which dissolves the material of which the varnish is composed. Soap does not injure it: it may be washed with soap and water, and therefore washstands may be varnished with it.

803. *Receipt for the French polish.* To one pint of spirits of wine add 1½ ounce of shell-lac, ¼ ounce of gum copal, and ¼ ounce of gum arabic: all the gums to be bruised. Keep the vessel into which these are put well corked, and let it remain in a warm place for two or three days: then pour off the clear part into another bottle. To use it, place the piece of furniture under the eye in a good light. Make a rubber by rolling up a piece of fine cloth not very hard. Apply the polish to the end, covering the part with a piece of soft cotton rag that is free from lint: damp the rag with the best cold-drawn linseed oil in the smallest possible quantity, so that the polish may spread when rubbed. The oil may be applied to the rag with the end of a skewer, or some such instrument. Proceed to rub briskly, with a moderate pressure, in a circular direction, over a space equal to about a square foot at a time, and replenish both as the wood dries. Go over the whole surface in this manner, and give three or four coats according to the grain of the wood. The operation must be performed in a place of moderate warmth. Gradually clear off the oil from the surface with the polish, and sometimes turn the rag, otherwise the brightness will not be perfect. Be careful in using a frequent succession of soft and clean rags, since on that depends, in a great measure, the clearness of the polish. If too much oil be used in the operation, which is apt to be the case from the difficulty of spreading the varnish, the work is, after some time, liable to assume a bluish dulness, a fault which may be remedied by using the following preparation:

The ingredients are, rectified spirits of wine, half a pint; shell-lac, two drachms; benzoin, two drachms; put these in a bottle, and keep them in a warm place till dissolved. Then having let the mixture stand till it is cold, add two spoonfuls of the best linseed oil; shake it well, and it will be fit for use. The application may be made according to the above directions, only observing that a fine soft muslin rag made into a wad is preferable to cloth. The fluid must be well shaken while in use.

804. *A cement proper for filling up holes in mahogany* may be made by grinding upon a stone with oil of turpentine, some red-lead or Venitian red, Spanish brown, a little lake and yellow, so as to match the colour of the mahogany: this must be made as thick as paste: then take as much turpentine varnish as will barely soften it, and apply it to the cavity: in a day or two it will bear polishing like the wood.

805. *Glue,* a common substance for cementing, is made of skins, and other gelatinous parts of animals, boiled to a thick jelly, and then formed into a solid mass by spreading it out in thin layers upon a net, and drying it until it is quite hard, in which state it is sold. To use it, broken pieces should be soaked for some hours in water, which softens it, and occasions it to swell; some more water is then added to it in a glue-pot, and it is kept on the fire till it is melted. The strength must be judged of by observing how it falls from the glue brush. A lesson from a joiner will best teach its use, and a glue-pot is very handy in a family. *Jefferey's patent marine glue* is a cement not affected by moisture.

806. *Size* is sold in the shops ready for use, and is only a weaker kind of glue: the jelly, indeed, without having been hardened; but it is generally made of better materials. It is dissolved by putting it into a pipkin over the fire. It is employed to mix with distemper colours or whitewash, to prevent their rubbing off, and for similar purposes.

CHAPTER III.

ON THE MATERIALS EMPLOYED IN FURNITURE.

807. *The nature of the materials used in the various articles of furniture* is a subject, among others in domestic economy, that it is useful to understand. A judicious choice of furniture cannot be made without a knowledge of the substances of which they are formed, since upon the various qualities of these their durability often depends, as well as the proper methods of preserving their strength, beauty, and usefulness.

It is more particularly necessary to have an accurate knowledge of the metals, on account of the expense of some, and the great damage that may be done to them through ignorance or inattention. In the utensils employed in our culinary processes, this sub-

just acquires an importance in another point of view. It is well known that several metals are of a poisonous nature, and serious accidents have happened in consequence of their improper use. The same judgment of the mistress or the housekeeper, therefore, which watches over and regulates every part of the household, should be exercised and extended to the furniture and utensils of the cook, who is too often but imperfectly acquainted with those facts which it is so important that all should know. Nor are tradesmen, and even the manufacturers themselves, to be always depended upon for information respecting the materials they employ, many of them being ignorant of the difference between a simple metal and an alloy, knowing the latter only by a name, and having erroneous ideas respecting its composition with respect to the latter, indeed, the grossest quackeries and impositions are daily put forth and practised, sometimes through fraud, but in some cases also from ignorance. We consider, therefore, that it would be useful in this work to supply some information on this head.

SECT. I.—WOODS.

808. *General observations.*—Much of the beauty and excellence of modern furniture depends upon the judicious selection of the wood of which it is constructed: and of this there is now a considerable variety.

We have already, in our history of Furniture, mentioned the taste of the ancient Romans for beautiful kinds of wood. Anciently, in Britain, the native woods alone were worked into furniture, and of these the oak had the preference; but after the acquisition of mahogany, the beauty of which far surpassed all others then in use, our native woods were much neglected, although some of them possess great merit, and had formerly been studied with attention to their curious curling veins; of late these have come again into fashion, together with new species from distant countries. Woods vary much in their colours: some are of a kind of chocolate colour, as mahogany, cedar, rosewood; others are of a light yellowish hue, as walnut-tree and satinwood; others, again, are almost white, as pear, plane-tree, and deal. Their hardness, and of course their durability, and the property of receiving a polish, vary considerably. The most valuable and beautiful woods for the best furniture are mahogany, rosewood, satinwood, zebra, and Coromandel wood. For certain parts of bedsteads, chairs, and sofas, beech and elm are employed; oak for strength and for Gothic furniture; the cherry, plane, holly, yew, box, walnut, lime, poplar, and a great variety of others for occasional purposes; and deal enters more or less into the construction of almost every article. Many of the more expensive kinds are very nearly imitated by staining and painting; but these processes, though much employed and extremely useful, fail in durability where there is much wear. Varnishing the woods themselves, to exhibit the grain, greatly improves their appearance; and since veneering has been so much employed, and the French polish has been in use, the splendour of fine woods in our furniture has become very remarkable.

809. *These various beauties and merits depend, in a great measure, upon the natural structure of wood in general*, and the manner in which it grows. The varieties of wood usually employed in Britain are produced by that class of trees termed by botanists *exogenous*; that is, which increase in thickness by a yearly addition of a circular layer of new wood, which grows between the bark and last layer. A section across such a tree, *fig.* 157, exhibits a number of concentric rings of wood, equal to that of the years which the tree has been growing. Each of these rings is unequal in density in different parts, being composed of a hard substance on one side and a soft substance on the other, both of which generally graduate, more or less, into each other, the colour being at the same time different, which enables us to count them with tolerable facility. The whole substance of wood is composed of two kinds of minute parts: one consists of very small hollow globules invisible to the naked eye, and the other of bundles of tubes finer than human hairs. The most solid parts contain the greatest proportion of the latter. Besides the concentric rings just mentioned, which form a series of hollow cylinders, one within the other, there are thin plates of dense wood, which extend nearly from the centre to the circumference of the trees in a radiating manner, and consequently crossing the last-mentioned concentric layers. These radiating plates constitute what the cabinet-makers call the *silver grain*, which is very conspicuous in some woods, and which often has a principal effect in producing the elegant stripes so frequently seen. Besides the very minute tubes and cellular tissues which always constitute the substance of wood, there are likewise many tubes passing through the lengthway of the tree, which are so much larger than the rest as to be visible to the naked eye, and which, when divided longitudinally, appear as minute grooves on the surface, and give a coarseness of grain. This is particularly observable in the coarse mahogany and in oak; and they catch and hold the dirt, and then appear as dark lines on the surface. In some of the close-grained woods, as lime, pear-tree, beech, birch, and lignum vitæ, these large tubes either do not exist, or are not

Fig. 157.

sufficient in size to be conspicuous; and the wood appears, even when examined by a high magnifier, to be composed of fine shining threads, not tubular, the hollowness being too minute to be easily ascertained. The various striped, wavy, curled appearance of the various woods, depend much upon the direction in which these parts are cut across by the saw. Another variety in the figure of woods is the occurrence of eyes, round spots, and small curls, which, although hardly suited to the larger kinds of cabinet work, is often extremely ornamental in smaller articles, as stands or work tables. Birds' eye maple, Amboyna wood, and the root of the common yew and elm, are perhaps the most beautiful in this respect.

910. *Another class of trees* is that termed by botanists *endogenous*, *fig.* 186, the structure of which is very different. These may be exemplified by palms and bamboos, and is well seen in the common *ratan* cane. The trees have their stems straight, and their leaves only at the top. In the section of the stem no radiating lines are seen, but only very minute circles, which are the ends of tubes disposed longitudinally. Trees of this kind grow only in warm climates, and their wood is not employed for furniture in this country in the manner of exogenous trees.

911. *Mahogany.* There are two kinds of mahogany in common use for furniture. The finest and most valuable kind is imported from St. Domingo and Jamaica, and designated by the cabinet-makers Spanish mahogany; the other is inferior and coarser, called Honduras, being the produce of the British colony of that name in South America. *Spanish mahogany*, being brought from a foreign colony, is subject to a very heavy import duty, charged by weight. It is very hard in texture, and the grain is close and has a silky aspect; the pores are short, and sometimes are scarcely to be observed; consequently it receives a fine surface and polish, and is always used in the best dining-tables, sideboards, and other articles of good furniture, for which it is admirably adapted, not only on account of the closeness of its fibre or grain, which prevents its harbouring dirt, but from its beautiful mottled, wavy, and curled appearance, in which, together with its rich colour, it excels all other woods. The cabinet-maker runs a considerable risk in purchasing mahogany, as he is often disappointed in the quality of the wood; that in the interior of the log, when sawed up, sometimes not answering the expectations which were formed from the examination of the outside. *Honduras mahogany*, being imported from a British settlement, is charged with much less duty. In most instances it is very inferior to the Spanish: it is of lighter weight, and softer in substance; and, the pores being wider and longer, it is not susceptible of so fine a polish. It is liable to retain and absorb more dirt: if wetted, especially when new, the surface becomes rough and woolly. The logs of Honduras are, in some cases, very large, measuring nearly four feet in diameter; but its general value is about one half or two thirds of that of Spanish.

912. Although we have stated that Spanish mahogany is superior to Honduras, yet that must be understood generally; for some logs of the latter are occasionally found equal to the former; and, from this circumstance, it is not always possible for the most practised eye to determine which of these two woods a piece of furniture consists of, instances occasionally occurring, though rarely, where Honduras has all the beautiful curl and close grain of the Spanish. It is a practice with some cabinet-makers to stain mahogany to improve the colour: this stain is apt, in time, to change. Good mahogany is never stained.

913. *The history of mahogany* is rather interesting.

The first mention of the employment of mahogany was in the repair of some of Sir Walter Raleigh's ships at Trinidad, in 1597; but the discovery of the beauty of its grain for cabinet work was accidental, about the beginning of the eighteenth century. It is thus related by Mr. Phillips, in his work on "Fruit-Trees." Dr. Gibbons, an eminent physician, was building a house in King-street, Covent Garden. His brother, who was a West India captain, brought over some planks of mahogany as ballast, which he thought might be serviceable in his brother's building; but the carpenters finding the wood too hard for their tools, it was laid aside as useless. Soon after, Mrs. Gibbons wanting a candle box, the doctor called on his cabinet-maker (Wollaston) to make him one of some wood that lay in his garden. Wollaston also complained that it was too hard; but the doctor insisted on having it made, and, when finished, it was so much liked that the doctor ordered a bureau to be made of the same wood, which was accordingly done; and the fine colour, polish, &c., were so pleasing, that he invited all his friends to see it. Among them was the Duchess of Buckingham. Her grace begged some of the wood of Dr. Gibbons, and employed Wollaston to make her a bureau also. On this, the fame of mahogany and Mr. Wollaston was much raised, and furniture made of this wood became general.

914. *Rosewood.* This is a favourite wood for many smaller articles of furniture, although it is apt to be too dark. It grows in Brazil, and is considerably more expensive for furniture than mahogany, partly on account of the price of the wood, and partly from that of the workmanship, it being very hard. Many articles of rosewood furni-

ture are veneered, but the best are of solid wood. The colour, which consists of large elongated dark zones on a reddish-brown ground, is permanent, except it be much exposed to the rays of the sun; and it takes a fine polish, which is improved by slight waxing, or, what is better, by the French polish, which brings out the colour of the wood admirably.

815. *Satinwood.* This very elegant, light-coloured wood, so denominated from its silky aspect when polished, is employed for a variety of purposes in cabinet work, but chiefly in conjunction with other woods. It is very expensive.

816. *Coromandel wood* is, perhaps, the most beautiful of the brown woods, consisting of pale reddish-brown fibres crossed by large stripes of deep, rich brown, with various veins and spots; the lustre silky.

817. *Cedar.* There are two kinds of wood known by this name in cabinet work, but neither of them is the true cedar of Lebanon. *The sweet-smelling or pencil cedar* (*Juniperus Virginiana*) is a native of North America and the West India islands. The wood is of a brownish-red colour, has a well-known agreeable odour, and is very durable, being unattackable by insects. It is employed in manufacturing drawers, wardrobes, &c., for which it is valuable, on account of its property of keeping away moths. It is soft, but of a uniform texture, and light. Some recommend that all cabinets or sets of drawers should have some of this wood as a material in its manufacture.

818. *The Havana or Bermuda cedar* (*Juniperus Bermudiana*) is another variety, a native of Bermuda and the Batavia islands, and also employed in various articles of furniture. It somewhat resembles mahogany, but is much softer.

819. *Oak.* Our native oak is of a dark colour, and, though much used formerly in furniture, and ornamented with carving, is now generally superseded by the Riga oak, called *wainscot,* which is of a light yellowish tinge. This is usually varnished, which prevents the dust from filling up the pores of the wood, and causing it to become darker; or it may be well rubbed with a small quantity of the wax polish. Wainscot being of an agreeable colour, cheaper than mahogany, and not being liable to warp, is much employed. It is, likewise, used conjointly with mahogany, as in drawers, the latter constituting the fronts, the former the interior.

820. *Pollard oak.* This native, beautiful wood has a distinguished claim upon our attention, from its intrinsic merit. It has been recently introduced as veneers sawed off from the stumps of old pollard oaks, that otherwise would have been consigned to the flames; but which, when cut, are found to contain the richest variegated spots and figures, arising from knots and irregularities of growth, that, when brought out by polish, are extremely various and beautiful. This wood is, however, usually decayed in parts and perforated by insects; that these defective places have to be filled up with the greatest neatness and care by the workmen, with other pieces of wood let in, which causes it to be expensive: various pieces are frequently veneered in one table top to produce an elegant pattern.

821. *Walnut-tree.* This native wood is now little used for furniture; but, before mahogany and other foreign woods were imported, was much in request for the beauty of its grain. It is much employed by the coach-builder, and for making gun stocks, being lighter, in proportion to its elasticity and strength, than any other.

822. *Elm.* This is little used in furniture, as it twists and warps too much; but, as it is very tough, and not liable to split, is very useful for some purposes, as for chopping blocks, and tops of kitchen tables; and, on account of its great durability in water, it is employed in pumps, pipes, planks and piles in foundations, coffins, and sometimes for the naves of wheels.

823. *Ash* is a wood but little used in furniture, but, from its toughness, is useful in some cases.

824. *Pear-tree.* This wood is of a light yellow colour; and being very uniform, and easily cut, though firm and solid, it is occasionally used for carving, also for measuring rules and similar purposes.

825. *Ebony* is a wood naturally of a deep black colour, and highly prized by the cabinet-maker for several purposes, particularly inlaying. It is exceedingly hard, heavy, and durable; but is only used in a small quantity. As it is expensive, cabinet-makers often substitute pear and other woods dyed black; but these are not so susceptible of good polish and lustre, nor do they keep their colour equal to true ebony. The best ebony comes from Africa; a kind variegated with brown is brought from Mauritius and Ceylon.

826. *Box-wood* is a close-grained, hard wood, of a yellowish white colour, and takes a fine polish. Its heaviness prevents its being much used in furniture, except for inlaying and smaller works. It is much used in instruments, particularly in musical wind instruments. Its bitter quality prevents its being attacked by insects. It is the wood of a shrubby evergreen that, in some places, grows to the height of twelve or fifteen feet.

827. *Bamboo.* This cane grows in India and China, and is there very extensively employed for a vast variety of purposes. It is one of the most common plants in those

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sehold moveables, are entirely con-
bles, for sails, for cables, for rigging,
or carts, for wheelbarrows, wheels to
nd a variety of other utensils, as bas-
s furnish an article of food, and the
ich are also twisted into cordage, and
is remarkably light and strong; but
tity to manufacture it as in the East.
of bamboo, as chairs and bedsteads,
bly curious.
irs are made, is a small sort of cane
exceedingly tough, and, for the pur-
as they are twisted into cables.

RY.

nployed in ornamenting articles of fur-
Greeks, even for colossal statues of
of gold and ivory. In modern times,
by the sculptor; but it is seldom now

he tusks of the elephant consist, though
horse and of the hippopotamus. The
here elephants exist in great numbers.
tity of it is shipped, has obtained the
s, also, from the east coast of Africa.
ccount of its whiteness. The compo-
of bones, namely, phosphate of lime,
proportion of the latter is so consider-
dissolved by digestion in boiling water,
with bone. Heat does not soften ivory,
100 parts of ivory contain 64 of phos-
te of lime. It is worked with the saw
[illegible] ipoli. It admits of being easily stained of various colours; and, when long exposed to the air, its beautiful white colour is changed to a dull yellow. Bleaching with chlorine will restore it to its original whiteness. When burned in a close crucible, it makes ivory black. The size of the tusks varies according to the age of the animal, the largest being about ten feet long. Those from Guinea weigh about from 100 to 120 pounds. The tusks are always more or less curved; from which circumstance, and their small diameter, this material can never be had of a large size; and, though in countries where ivory is found, as in India, considerable articles of furniture are executed of it, it is found too expensive for that purpose when brought to this country.

831. *The teeth of the sea-horse* are much harder than the ivory of the elephant, and the enamel is used for making artificial teeth.

832. *Carvings in ivory*, when not kept under glass, sometimes become covered, in time, with a multitude of minute cracks, which get filled with dirt, and deface them. Glass not only protects them from this, but affords the means of bleaching or whitening ivory that has been discoloured. This effect is produced by exposing them to the sun's rays under glass, turning each side, in succession, to the rays of that luminary. To remove the cracks above alluded to, the ivory should be washed in soap and warm water with a brush till the cracks disappear, after which it should be placed under glass for preservation.

833. *Ivory may be silvered in the following manner:* Immerse the ivory in a weak solution of nitrate of silver, and suffer it to remain till it has acquired a deep yellow colour; then take it out, wash it with water, and expose it to the sun's rays, which will turn it black in about three hours: the ivory will, upon being rubbed, acquire a silvery lustre.

834. *Vegetable ivory* is a singular substance lately introduced, and which is occasionally worked into small articles. It resembles ivory exactly, though somewhat more brittle, and more liable to change colour. It is the seed or nut of a plant (*Phytalephas macrocarpa*), having a character between a palm and a cycas, and growing in the valleys of the Peruvian Andes. The nuts are about the size of a hen's or pigeon's egg, and have been used from time immemorial by the natives of South America for the same purposes as ivory.

SECT. III.—MARBLE.

835. *All marbles are carbonates of lime;* that is, they consist of carbonic acid and lime. Of course, they are the same as chalk, only that they are crystallized, which gives them their hardness, whereas chalk is of a soft, earthy texture. Marble is corroded and dissolved by acids, and it agrees in its composition with limestones; whenever the latter are of such a texture as to admit of a polish, they are called marbles.

836. *Marble is slowly rendered more brittle, and thus slabs are sometimes even bent by long-continued heat*, as may be seen on the mantles of some chimney-pieces, where they are much exposed to the heat of the fire. White marble becomes easily stained by smoke and dust, and sometimes it is stained artificially of various colours for useful purposes.

837. *The purest white marble is termed statuary marble*, and comes to us from abroad, chiefly from Italy. It is the most expensive, as well as the most elegant. The veined marble is also imported, as well as several of the coloured marbles.

838. *Rare and beautiful marbles*, in almost endless variety, are much sought after for tops of small tables, and similar pieces of furniture; and some of these fetch very high prices. It requires no small skill to distinguish accurately the different sorts, which are frequently incorrectly named. Some substances, also, are called marbles that are not strictly so; for example, *serpentine*, which is not a carbonate of lime, but consists of silica and magnesia. The Florentine alabaster is sometimes incorrectly classed with marbles; but it is sulphate of lime, and does not effervesce with acids as marbles do. We have in Britain and Ireland many variegated marbles of great beauty, which are occasionally used in furniture.

839. *For the method of cleaning marbles*, see the section "On cleaning Furniture."

SECT. IV.—ALABASTER.

840. *This substance has a near resemblance to marble*, but is distinguished from it by greater transparency.

841. *There are two kinds of alabaster:* one is a carbonate of lime, and therefore is of the same composition as marble, but has been formed, in the manner of a stalactite, by water dropping in a cavern. Though very transparent, it is also very hard, and therefore seldom used for sculpture. The other kind is a sulphate of lime, and the same substance as gypsum, from which plaster of Paris is made; but gypsum is called alabaster only when it is translucent, and has a grain resembling that of marble. *Gypseous alabaster*, being soft and easy to cut, and having often great beauty and transparency, is much employed for some ornamental works, particularly vases, stands for time-pieces, and similar things. Much beautiful alabaster being found near to Florence, the business of manufacturing these ornamental articles is much prosecuted there, and also at Leghorn and Milan. Objects of this kind, made of alabaster, are liable to become yellow, particularly if exposed to any smoke, but they may be restored, in a considerable degree, by washing with soap and water, and afterward polishing with shave-grass. Grease spots may be removed by rubbing the places with powder of French chalk, which is a kind of talc. As the alabaster is very soft and tender, they are easily scratched or broken, and therefore require to be taken great care of; if valuable, they should be kept under a glass. Broken parts may be joined together again by quicklime and white of egg. Alabaster may be easily stained with metallic solutions, by the spirituous tinctures of dyeing substances, or by coloured oils, in the same way as marbles.

SECT. V.—SCAGLIOLA.

842. *This is a material which is made to imitate various marbles, porphyry, and serpentine*, so well, that it is difficult to discover, by the appearance, that it is not real stone. It is much employed for columns in the interior of houses, also for lining parts of walls; and for table tops, stands and pedestals of various kinds for statues, busts, &c., and other ornamental parts where marble is used. It admits of a very beautiful polish, but cannot be employed in the outside of a building, as it is destroyed by damp, and requires to be kept very dry. It is chiefly composed of plaster of Paris and glue, coloured by different pigments. These are mixed together separately, according to the various parts of the marble to be imitated, and while they are in a moist state, are stirred together like the veins in marble. This substance is very useful where great richness and magnificence is required at small expense.

SECT. VI.—LEATHER.

843. *The skins of animals were among the most ancient materials* employed for clothing, and for certain parts of furniture. But, although these are pliable when recently stripped from any quadruped, as they dry, they shrink, become hard, like horn, and will no longer adapt themselves to the free motion of the parts they are intended to cover. Some process is therefore necessary to restore their original flexibility and suppleness,

and to preserve them permanently in that state. Skin so treated is said to be converted into *leather*. The art of preparing leather is of great antiquity; we find it described in the poems of Homer, and it has been practised by the eastern nations from time immemorial. The objects of this art are to prevent the destruction of the skin by putrefaction, and to render them strong, tough, durable, and impervious to moisture, at the same time that they admit of dyeing and polishing.

844. *Skins may be converted into leather by three methods.* The simplest, and probably the first that was invented, consists in soaking the skin in water, and then forcing oil or grease into its pores by hard rubbing. The oil, which is thus introduced among the fibres in the place of the water, preserves the suppleness of the skin as long as it remains there. This method is mentioned by Homer; and the North American Indians prepare in this manner their deer and buffalo skins. They soak them in a mixture of the fat and brains of the animals, rub them well with their hands, and afterward hang them up in the smoke, which assists, by its antiseptic property, in preventing their putrefaction.

Leather is made in this country chiefly by two processes—by *tanning*, and by *tawing*; and both of these are sometimes combined, as in sheep, goat, and deer skins.

845. *The tanning of leather is effected* by steeping the skins, properly prepared, in infusions of astringent vegetables, as oak bark. Although this has long been successfully practised, yet the principles upon which the process depends were not understood until about the beginning of the present century; modern chemistry threw light upon the subject. It had been supposed that the effect of hardening and thickening the skin was owing merely to that peculiar corrugation which is perceived when astringent juices are taken into the mouth, and the lips are puckered and constringed, and that the fibres were thus brought closer together. But M. Seguin, a French tanner, and a man of science, discovered that the effect produced by tanning was not of a mechanical, but of a chemical nature. The skin is composed of two parts or layers; the outer one is thin, and is called the *cuticle* or *epidermis*, and the inner is named the *cutis* or *true skin*. The cutis consists of minute fibres, which are composed of gelatin or glue, as is evident, because that substance is produced by boiling skin till it is dissolved. Now M. Seguin discovered that, when gelatin is dropped into an infusion of oak bark, or any vegetable astringent, a brown precipitate falls down, consisting of a combination of the astringent matter with the gelatin; and that this new substance was insoluble in water, and was that, in fact, which leather contained, and to which it owes its properties. The astringent principle which thus combines with the gelatin of the skin M. Seguin named *tannin*, or tan. When skin is tanned, therefore, a chemical change takes place in its nature; it resists the action of water, and is no longer capable of putrefaction. Besides tannin, astringent vegetables contain another principle, *gallic acid*, which, as well as tan, has the property of forming an ink or black liquid with the salts of iron; hence leather is easily rendered black by rubbing it over with a solution of green vitriol or sulphate of iron. What we have just stated is the chemical principle upon which the making of tanned leather depends; but in the practice of tanning a variety of circumstances are to be attended to. The various kinds and qualities of leather are owing to the different skins employed, or the modification of the art of tanning, in order to suit them for their several uses. Some are made very thick and strong, for the soles of shoes; others are rendered soft and pliable, being intended for the upper leathers of shoes, for gloves, and other articles.

846. *Leather tanned in England consists chiefly of three sorts:* the thickest and strongest kind, used for the thickest soles of shoes, is known by the name of *butts* or *backs*, and are made of the stoutest and heaviest ox hides. The next in thickness, used for thinner soles of shoes, are called *crop hides*, and are made of cow hides or lighter ox hides. The third sort is named *calf skins*, and are made from the skins of calves, horses, seals, dogs, &c.; they are used for the upper leathers of shoes, boots, &c.

Besides the skins of animals recently slaughtered in this country, many are imported in a dried state; those of cows and bulls chiefly from the pampas of South America; sheep skins from the Cape of Good Hope; lamb and kid skins from Italy; and goats' skins from Barbary, &c. Different tanners and leather-dressers have, generally, some parts of the process peculiar to themselves; but the following are those which are usually practised in this country.

847. *For butts, or the strongest sole leather*, after the horns are taken off, the hides are laid smooth in heaps for a few days, after which they are suspended on poles in a close room called a smoke-house, where the temperature is kept somewhat elevated by a smouldering fire of wet tan. This occasions a slight putrefaction, which causes the cuticle with the hair to be got easily off by spreading the hide on a wooden horse, and scraping it with a crooked knife. The reason for taking off the cuticle is this: it is not formed of gelatin, like the cutis, but of albumen; it is analogous to thin horn, is incapable of combining with tannin, and would prevent the latter from acting upon the true skin. The hides are then put into a pit containing a strong infusion of bark, called *ooze*, which operation is termed *colouring*; after which they are removed into another

pit containing water impregnated with about a thousandth part of sulphuric acid: this is called *raising*, and is for the purpose of distending the pores of the hides, and occasioning them more readily to imbibe the tannin infusion, which is to combine with the gelatin of the skin and form leather. They are next transferred into a pit, where they are disposed with ground oak bark between each layer of hides. The pit is filled up with ooze, and the hides remain in this for about a month or six weeks. By that time all the tannin of the bark has combined with the skin, and the liquor is then drawn out, and fresh ooze and bark put in as before. The skins lie in this for three months, at the end of which time the process is repeated; and after remaining four or five months longer, they are usually completely tanned, except the hides are remarkably thick, when they may require another repetition of the process. The time required for tanning in this manner is from a year to eighteen months, or even two years. They are now taken out of the pit to be dried by being hung on poles, and they are then beaten smooth with wooden hammers, called batts, and compressed with a steel tool to render them more firm, when they are fit for sale.

848. *When the leather called crop hides is to be made*, the skins are put into a pit full of water saturated with lime for a few days; they are then taken out, and the hair is scraped off, and afterward the loose flesh and other superfluities. Next they are put into a pit with weak ooze of oak bark, from which they are transferred to pits with stronger ooze; all the time they are daily moved about, which is called *handling*. After this is continued for about six weeks, they are placed in a pit with strong ooze, with bark between each two layers. In this they continue several months, and this last process is repeated several times, till the hides are perfectly tanned; they are then dried and smoothed.

849. *The leather called calf skins* are tanned by a process somewhat different. These, after being washed in water, are put into pits with limewater, as before mentioned, where they are taken up and put down again every third or fourth day, for a fortnight or three weeks, in order to destroy the cuticle or epidermis of the skin. The hair is then easily scraped off, and the grease and loose flesh being removed, they are put into a pit of water impregnated with pigeons' dung, called a *grainer*, forming an alkaline lye, which, in a week or ten days, soaks out the lime, grease, and saponaceous matter. During this period they are several times scraped with a crooked knife to work out the dirt. The skins are thus softened and prepared for the reception of the ooze, in which state they are termed *pelt*. They are then put into a tan pit with weak ooze; and, after remaining there a sufficient time, are transferred to others with stronger ooze, until after six weeks they are put into very strong ooze with fresh bark, where they lie for several months till they are completely tanned. They are then dried as the others.

850. *The lighter sort of hides, called dressing hides*, used for coach work, harness, &c., are managed nearly in the same manner as the last, and afterward go to the currier. In consequence of the application of chemical science to the subject of tanning, it was expected that the time employed in the process might be very much shortened, so much so as from a year and a half to two years, to a few months; but the combination of the skin with tannin is a slow process, and it requires a long time for the tan to penetrate to the centre of the hides. Although, by making stronger infusions of the bark, leather could be made in a few months, yet such leather was found to be harder, and more liable to crack. Even the method described by Mr. Babbage as a recent improvement, namely, forcing the bark liquor into the pores by exhaustion with the air pump, is not found to answer. Weak infusions of tan, applied for fifteen months at least, make the best leather; but, as tanned leather is sold by weight, there is a strong inducement to the manufacturer to make his hides weigh as much as possible in the tan-pit, although at the expense of the toughness or compactness of the leather. Weak infusions not only take longer time to produce their effect, but also give leather of less weight; and the price which it fetches in the market is scarcely sufficient to make up for the increased expense in point of time.

851. *All barks contain more or less of the tanning principle*; but in this country oak bark is preferred, on account of its richness in tannin, and its abundance. In Russia, where the best of leather is made, the bark of the black willow is preferred, and next to this birch bark. But, of all the substances which have been tried, catechu, a sort of gum, contains the greatest quantity of the tanning principle. The tree which produces this grows in New South Wales, from which we shall probably obtain it at a cheap rate.

Oak bark being a very expensive article in the process of tanning, various substances have been proposed as substitutes for it. All the parts of vegetables which are of an astringent nature contain this principle (which may be known by their giving precipitates with gelatin insoluble in water), and will answer this purpose. The leaves, branches, fruit, flowers, of a vast number of plants; every part of the oak, as the leaves and acorns, oak sawdust, and the barks of all trees, contain more or less tannin. From experiments which have been made, the following are the quantities of the tanning principle in various barks.

	grs.		grs.
Bark of elm	28	Bark of willow	59
——— oak cut in winter	30	——— mountain ash	60
——— horse-chestnut	30	——— poplar	76
——— beech	31	——— hazel	79
——— willow (boughs)	31	——— ash	82
——— elder	41	——— Spanish chestnut	98
——— plum tree	58	——— smooth oak	104
——— willow (trunk)	52	——— oak cut in spring	108
——— sycamore	53	——— Huntingdon or Leicestershire willow	109
——— birch	54		
——— cherry-tree	59	——— sumach	158

852. *The thickest leather*, used for the soles of boots and shoes, requires nothing more than the process above described; but that which is wanted to be supple and soft, such as the light cow hides, and those of calves, horses, dogs, seals, &c., and for the upper leathers of shoes and legs of boots, also for coach and harness leather, saddles, and other things of that kind, are subjected to another process after the tanning is finished, called currying.

853. *Currying consists* in steeping the leather in water, covering one surface with a mixture of oil and tallow, and then stoving it. As the water evaporates, the oil takes its place in the pores of the leather; the *grain* side, to which the hair was attached, is then rubbed over with a solution of sulphate of iron, which strikes a black with the tannin of the leather. Beating and passing it between rollers, to smooth its surfaces, is the last process. If the flesh side of the leather is required to be blacked instead of the grain side, it is rubbed over with a mixture of lampblack, oil, and tallow, called waxing.

854. *The tanning principle in oak and other barks is sometimes applied to the purpose of preserving other substances besides skins.* Fishermen resort to this to render their nets more durable, and the sails of their boats are sometimes treated in the same manner: the application to other articles is obvious. The method of impregnating nets, cordage, &c., with tannin is the following: Two pounds of glue are dissolved in fifteen gallons of water: the nets are dipped into this solution, and steeped in a strong solution of oak or other good bark. The tannin combines with the gelatin, and envelopes the fibres of the hemp with a leathery coating, which prevents the action of the water and the weather. Any gelatinous substance will answer instead of glue: enough might be obtained from many parts of fish now thrown away.

855. *Tawing is the preparation of leather by a combination of tanning and aluming*; and is used for sheep, goat, kid, and other light skins for gloves, bookbinding, and a variety of other purposes.

When the skins of animals just slaughtered are to be tanned, they should be washed immediately and then dried, otherwise they soon ferment and begin to putrefy. When received in the dry state for tanning, they are steeped in water for two days, and the rough parts are removed by the fleshing-knife. The flesh side of the skins is now rubbed with a mixture of lime and water, and the skins are piled on each other with the flesh sides in contact: in a few days it will be found that the wool or hair may be easily removed. They are next well washed, to get rid of the lime, and again cleaned of their superfluous parts. This liming and cleaning is repeated several times. After this they are kept for eight or ten days in a bath of bran and water, which gives them a half tanning. They are then ready for the process of aluming, which is that properly which converts them into leather. A bath of alum and sea salt dissolved in water is prepared; into this the skins are put, at a heat near to boiling, for about ten minutes, and then wheat flour is dusted into the bath with the yolks of eggs, so as to make a kind of paste: the skins are well worked in this, and left in it for a day. It appears that the skins imbibe something in this process (perhaps alumin) from the alum, which cannot be separated by subsequent washing. After this they are stretched, rubbed, stoved, and occasionally polished with pumice. Smoothing with a hot iron, or pressing, finishes them ready for the glover. White kid leather requires the process of being worked in a mixture of eggs, salt, and alum, to render them perfectly white and soft, but the tanning is omitted. If the wool is to be preserved upon the skins, the treatment with lime and limewater is not used, and the alum paste is merely applied to the flesh side, and the skins folded up with it for some time. The rest of the process is nearly the same. Leathers are dyed after they have undergone the process of tanning, and a great deal of these are used for covering chairs, tables, and other articles of furniture.

856. *Morocco leather*, called also *Turkey leather*, is prepared from goat's skin, and receives its name from having been originally brought from Morocco, and other places in the north of Africa. At present some comes from the Levant, but the greater part is prepared in this country. The process employed in making it is nearly the same as that already described, only that it is tanned with sumach, and then dyed on the side of the grain; red with cochineal, blue with indigo, purple with orchal, &c. Some inferior morocco is made from sheep skin.

857. *Russia leather*, well known for its property of not being attacked by mould or worms, is first steeped in an alkaline lye, then in dog's dung: it is afterward fulled and tanned with the bark of birch, and dyed; the peculiar odour which renders it so useful in bookbinding is given by rubbing it over with the empyreumatic oil of birch. The roughness on the surface is produced by an iron tool pressed upon it.

858. *Maroquin leather* is of excellent quality, and is extensively prepared at Astracan and other parts of Asiatic Russia. The process for making it is nearly the same as for Russia leather, and it is dyed yellow or red.

859. *Shamoy, or wash leather*, properly *chamois leather*, is so called because originally, and when of the best quality, it was made from the chamois or wild goat inhabiting the Alps and Pyrenees. It is now made here, chiefly from the skins of deer, goats, and sheep. It is essentially distinguished from the other kinds of leather, in being dressed with oil, without salt, alum, or tan, and in the grain of the skin being taken off. The skins are brought to the state of pelt by liming and washing, as described above. Those skins which are to be of a buff colour are dipped in tan ooze, not to tan, but to dye them. The grain side is next scraped away by a knife, or rubbed off by pumice stone, which renders the skin softer and more extensible, yet sufficiently strong and elastic. They are then soaked in water, and oil is forced in by beating in a fulling mill till the skins have thoroughly imbibed the oil, yet without appearing greasy. They are then stoved, to facilitate the combination with the skin; and, to take away any superfluous oil, they are scoured in water with a little alkali. They are then dried, and smoothed by rollers. Until lately, vast quantities of shamoy leather was made and used in England, chiefly for dress; but it having been observed, during the late campaigns in Spain, that the health of the soldiers was seriously affected by the leather which they wore, which produced chilling and rheumatism by its fitting close to the skin, and being long in drying, the use of it was laid aside, and woollen cloth substituted.

860. *Buff leather* is a very thick and firm, though pliable sort of leather; the true kind is prepared from the skin of the buffalo, and dressed in oil, much in the manner of chamois. Real buff leather is so strong that it will turn the edge of a sword, and is said to be sometimes even pistol proof: hence it was much used for military purposes when metallic armour was going out of use, about the time of Charles II. But the buff leather of modern times is made mostly from cow-hides, which are inferior, and it is used chiefly for soldiers' sword belts, or where great strength is required with great pliability.

861. *Seal skin*, being covered with a very short smooth shining hair, is used sometimes for making waistcoats, and in other places for jackets: also for covering trunks; but are nearly laid aside for the latter purpose, as an insect breeds in them very frequently that attacks the hair.

862. *Parchment* is a very ancient preparation from skins, used for writing upon; and, from its great durability, is still employed for the same purpose in the case of valuable records. It is made of the thinnest sheep or goat skins. After the hair and flesh are cleaned off in the lime pit, the skins are soaked, drained, stretched upon frames, dried, and rubbed with pumice stone and chalk, and then pared to bring them to the required thinness. It is sometimes dyed of various colours.

863. *Vellum* is a superior kind of parchment, not passed through the lime pit, and is made of thinner skins. It is finer, smoother, and whiter than common parchment. Lately, several machines have been invented for splitting hides, by which one half is converted into leather, and the other into vellum or parchment.

Shagreen is a valuable material, used often for spectacle, instrument, and other cases, and is a singular manufacture, brought chiefly from Astracan. To make it, they choose the strong skin that covers the crupper of the ass or the horse. This is soaked in water, and the hair taken off. It is then cut and scraped till it is extremely thin, and in this state, while wet and soft, small, round, hard seeds are strewed over it, and are trodden deeply into the soft, yielding skin. The skin is then dried and the seeds shaken out: the surface is rasped down till the whole is nearly but not quite level. It is then again soaked, and the parts which were depressed now rise above those parts which had been rasped. The skins are now dyed of a green colour, and allowed to dry. Lastly, the grains or projecting warts are rubbed down till the whole is completely level, when the shagreen presents the beautiful appearance of white dots on a green ground.

[The art of tanning is cultivated in this country to much greater perfection than in any other portion of the world; and many of the manufacturers of leather conduct the business on a scale and to an extent far beyond what is known in England. Within a few years very great improvements have been made by American ingenuity and skill, which are unknown to the old world, and by which the process of converting the hides into leather is facilitated, so that a perfect article is made in little more than one fourth of the time formerly required here, and, as it will be seen by the text, still deemed necessary in England.

The process, in some of its parts, is patented by the inventors, and still kept secret among the few who, having purchased the right to its exclusive employment, make the

monopoly a source of great emolument, while affording to sell the best leather at lower prices than their neighbours, by reason of their diminished expenses in the ratio of the abbreviation of the process. The improvement essentially consists in employing hot infusions of bark, by which the chemical action of the tannin is hastened; and, at the same time, rapidly effecting by machinery certain parts of the operation, ordinarily performed by hand, and demanding much labour.

In the large tanneries the bark mill is worked by a steam-engine, which, at the same time, drives all the other machinery, and conveniently provides the heat necessary for preparing the ooze with which the vats are filled. In some of the Atlantic cities the manufactories of leather are conducted on a scale of immense extent by men of large capital, who find the business very productive.]

Sect. VII.—PAPIER-MACHÉE.

864. *This substance, as its name imports, is made from paper reduced to a pulp* with gum or size, pressed in moulds, and afterward dried: it is at present very much employed in various ornamental works, which were formerly executed in plaster of Paris or carving, such as the enrichments in cornices and ceilings, picture frames, &c. It is originally a French invention, and was much in use sixty years ago, but had been almost laid aside for the above purposes; it was revived a few years ago. It had, however, been always employed for large tea-boards, trays, &c., for which it is admirably adapted from its great lightness and strength.

The black varnish for trays, &c., is prepared in the following manner: Some colophony or turpentine is boiled down till it becomes black and pliable; this is wetted in a glazed earthen vessel, and then as much amber in fine powder is sprinkled in by degrees, with the addition of a little spirit or oil of turpentine now and then: when the amber is wetted, the same quantity of sarcocolla is sprinkled in and stirred; then more spirit of turpentine is added, till the whole becomes fluid. The mixture is next strained through a coarse hair bag, by pressing it gently between hot boards. This varnish, mixed with ivory black in fine powder, is applied, in a hot room, on the papier machée, which is thus set in a gently-heated oven, next day in a hotter oven, and the third day in a very hot one, and suffered to stand each time till the oven is grown cold. The article so varnished is hard, light, and durable, with a fine gloss, and bears liquors, hot or cold, without injury.

Sect. VIII.—TEXTILE FABRICS.

865. These materials, which form so great a part of furniture, as silk, cotton, linen, and woollen, will be treated of among the substances employed as clothing or dress, in Book XVII.

Sect. IX.—HAIR.

866. *The hair of animals is employed in various articles of furniture:* when it is very fine and soft, it is termed *fur* (which see in Chap. IX., Book XVII.). Hair is used for stuffing mattresses, sofas, and chairs, and making sieves, and it is woven into a cloth for covering chairs and sofas. The best for all purposes is horse hair; but that from tails of bullocks is also good; the shortest hair taken off skins being only fit for being mixed with mortar for the plasterer, although a good deal of this is introduced among better kinds in inferior and cheap manufactures. When hair is to be prepared for mattresses, it is twisted round wooden cylinders and boiled, and then baked in an oven to give it a curly and springy form. The long straight hair is reserved for weaving into cloth for chair bottoms, for which purpose it is first dyed a deep black. The satin manner of weaving it is now most generally adopted as the most agreeable and the most durable. Hair is a very lasting substance, not being liable to decay through ordinary causes. It is insoluble in water, but is acted upon and dissolved by alkalies; much soap, of course, injures it.

Sect. X.—HORN.

867. *The horns of cattle are used for a variety of purposes in furniture as well as dress:* those of oxen are the largest and best. *Horn differs essentially from bone* in its constitution and properties. It contains little gelatin, whereas bone contains a great deal; and it consists chiefly of condensed albumen, with a very small portion of gelatin and phosphate of lime. Consequently, horn cannot be dissolved by heat, though it may be softened by it; and it may then be readily bent to any shape, and made to adhere to other pieces of horn in the same state, or pressed out into thin sheets. These properties belong to the hollow horns of the ox, goat, sheep, &c., and the hoofs of quadrupeds; the shell of the tortoise is nearly of the same quality; but the horns of the stag are very different, being composed chiefly of gelatin, and intermediate between horn and bone; they are soluble to a jelly in boiling water.

The horns of the bull and cow, sold by the tanner who had purchased the raw hides, consist of two parts: an outward horny case, and an inward conical substance, somewhat intermediate between indurated hair and bone, and termed the *core*.

868. *The first process in preparing horns for various purposes consists* in separating the horn itself from the included core, to which it is attached by a thin membrane; this membrane is destroyed by macerating the whole in water for about a month, and then the horn is easily separated by a blow. The horny exterior is then cut into three portions. The lowest of these, next the root of the horn, is softened, flattened, and made into combs. The middle of the horn, after being flattened by heat, and having its transparency improved by oil, is split into thin layers, and forms a substitute for glass in common lanterns. The tip of the horn, being solid, is used by the makers of knife-handles, and of the tops of whips and umbrellas, and for other similar purposes. The interior or core of the horn is boiled down in water; a large quantity of fat rises to the surface during this operation: this is put aside, and sold to the makers of yellow soap; the liquid itself is used as a kind of glue, and is purchased by cloth-dressers for stiffening. The insoluble substance which remains behind is then sent to the mill, and, being ground down, is sold to the farmers for manure, or is burned to ashes used in making cupels for chemists.

869. *Horn is prepared for lanterns as follows:* It is first softened by hot water, and then over a gentle fire, generally made of the stalks of furze, which enables it to be slit lengthwise on one side, and kept expanded flat by a pair of tongs while it is placed in a press between iron plates that are greased. Here they remain till they are cold. They are next soaked in water, divided into laminæ, which are scraped and pared down to the requisite thinness and transparency, with a large knife worked horizontally on a block. Afterward these thin plates are polished with willow charcoal and rotten stone. The Chinese are remarkably skilful in preparing this thin horn, as may be seen by a large globular lantern in the museum of the India House, about four feet in diameter, composed entirely of small plates of coloured and painted horn. Horn lanterns were also used by the ancients; for we find one mentioned in the *Amphitryo* of Plautus, and in an epigram of Martial: Pliny likewise speaks of lanterns and various ornamental articles made of dyed and painted horn.

870. *In Holland, France, and Germany, they make use of the parings* and clippings of horn and tortoise-shell, in the manufacture of snuffboxes, and a variety of elegant articles and toys. They first soften the material in boiling water, so as to permit its being pressed in iron moulds, which are heated in order to unite the whole into one mass. Care must be taken that the heat is not so great as to scorch the material; and grease must be carefully avoided, as that prevents their union.

871. *An artificial horn is made in France* from the gelatin obtained from bones, which is tanned by the same process as is used in making leather. When it is quite dry and hard, this assumes the appearance of horn, and it is coloured to imitate tortoise-shell. It is used for the same purpose as these substances, and when softened, by being boiled in water with potash, it is formed into any shape, and the figures are preserved by drying them between moulds. It is also inlaid, when in the soft state, with gold, silver, and other metals.

872. *Large combs, ornamented with open work, are used for the hair.* The tortoise-shell, or horn to imitate it, is first softened by boiling in hot water, till it can be easily cut by a steel die. Horn is coloured to imitate tortoise-shell, for combs and inlaid work, in the following manner: A compound is made by boiling together, for half an hour, pearl-ash, quicklime, and litharge, with a sufficient quantity of water, and a little pounded dragon's blood. This is applied hot to the surface of the plates of horn, and kept ti. the colour has struck; where dark streaks are required, the composition is to be applied a second time. This process, Mr. Aiken observes, is nearly the same as that employed for giving a brown or black colour to white hair, and depends on the combination of the sulphur, which is an essential ingredient in albumen, with the lead dissolved in the alkali, and thus introduced into the substance of the horn. When a dark shade is required, the dragon's blood is omitted.

873. *Horn is employed likewise for a great variety of other purposes.* Bows, having great elasticity, are made with it. The true bugle-horn was made of the horn of the Urus, or wild bull, tipped with silver, and slung in a chain of the same material. Complete suits of scale armour are made of horn in the East. Drinking cups are also made of it by softening, turning, and polishing.

SECT. XI.—TORTOISE-SHELL.

874. *This beautiful material is the shell or outside covering of the hawk's-bill turtle* (*Testudo imbricata*, Linn.), which is stronger, thicker, and clearer than that of any other of the tortoise tribe. A large turtle affords about eight pounds of tortoise-shell, which lies in scales, lapping over each other like the tiles of a roof. The animal is a native of the Asiatic and American seas, and is sometimes found in the Mediterranean; but its flesh is not esteemed as food, and the shell constitutes its only value.

Tortoise-shell is semi-transparent, and, being variegated with various spots of whitish yellow and reddish brown, constitutes, when properly prepared, one of the most elegant articles for ornamental purposes. The ancients appear to have been peculiarly partial

to this material, with which it was customary to decorate their beds and various parts of their furniture; and, in modern times, it is extensively employed for snuffboxes, combs, knife-handles, inlaying, &c. This shell is capable of so far being softened by steeping in hot water, that pieces may be joined together by placing the edges on each other, and subjecting them to a powerful press and hot iron; and, by the same means, ornaments of gold and silver may be applied to it. If, however, the heat is too great, the colours are much deepened, so as to become almost black, as is the case with moulded snuffboxes; for tortoise-shell, being less fusible than horn, cannot be made soft enough to be moulded without some injury to the colour; accordingly, combs of tortoise-shell, ornamented with open work, cannot be stamped out by dies like those of horn, but are obliged to have the perforations cut out by drills and other tools, while the graver is employed for the lines on the surface.

SECT. XII.—WHALEBONE.

875. *Whalebone is a horny substance found in the mouth of the whale.* This animal has no teeth, but, instead of them, a number of long strips of this substance, having fringes on their edges, through which it strains the sea water, and retains the food contained in it, consisting of abundance of small creatures. The number of strips of whalebone amounts to about 300; and they are from twelve to fifteen feet in length, ten to twelve inches broad, and from four to five tenths of an inch thick. They consist only of parallel fibres, consequently are easily rent or split. From its elasticity, strength, and lightness, whalebone is employed for many purposes: for stiffening stays; for ribs to umbrellas and parasols; for the framework of hats; and the shavings from the plane for stuffing mattresses, instead of hair. When heated by steam, it is softened, and may be easily moulded, like horn.

SECT. XIII.—MOTHER-OF-PEARL.

876. True mother-of-pearl, a beautiful substance, hard, and displaying a variegated play of blue, red, and green, is the internal part of the pearl oyster. It is easy to work, and takes a fine polish. As it is entirely calcareous, it is easily corroded by acids. But the beautiful iridescence for which mother-of-pearl is remarkable is still more striking in some other shells, particularly in the shell, not uncommon in this country, called the *sea ear*; and it is the inside of this, and not mother-of-peal, which is now so much employed in japanned work.

SECT. XIV.—FEATHERS.

877. Feathers are the peculiar covering of birds. In no other tribe of animals are they met with; and no bird is entirely without feathers, although some species want them on certain parts of the body; as the turkey and vulture, on the head and part of the neck.

878. *This clothing of birds is of two kinds, down and common feathers:* the former are placed under the common feathers; and some birds, when very young, as the goose, have no other covering. The down is designed to defend the bird against cold and wet; hence it is so abundant upon the lower surface of those which frequent the water, and it is most plentiful in those which inhabit only the coldest regions of the north. The common feathers are thickest upon the shoulders and loins, along the under part of the neck and breast.

879. *The large feathers, or quills,* situated upon the wings and tail, should rather be considered as instruments of motion than as mere covering; thus we find them strong and unyielding in those birds that have heavy bodies, as the swan, goose, turkey, &c., while they are wanting in those which do not fly, as the ostrich, &c. There are other long feathers that differ from the quills and common feathers with respect to their structure and position. Of these, we may mention those of the crest of the peacock, and some of the crane kind; also some of the feathers of the birds of paradise, which seem designed for ornament alone. The feather may be considered as divided into the tube or barrel, *a*, *fig.* 159, and the shaft, *b*. The tube penetrates the skin, and constitutes the root of the feather; it is hollow, semi-transparent, and horny, and contains a thin vascular substance that, when dry, forms that well-known jointed membranous body which we take out of the barrel of the quill when we make a pen. The shaft is elastic, and is quite filled with a very light dry pith. Two sides of the shaft are covered with the barbs, running in a direction from the barrel; and each barb is covered on the edges with smaller ones, or barbules, by which they are, in some measure, bound together, and preserve the bird from being wet. Upon the size, colour, and form of the barbs, the character and appearance of each kind of feather chiefly depends. In the down of all birds the shafts are exceedingly fine and delicate, and often imperceptible: the barbs are long, distinct, and floating; the barbules being long, loose, and silky.

Fig. 159.

880. *The feathers of all the birds employed as food are used for some purpose or other*; but they are not all equally fit for furniture: and feathers are likewise of various qualities, according to the parts of the bird from which they are taken. All feathers are more or less imbued with an oily matter secreted by the living animal, for the purpose of defending it more completely from rain and water, from which they must be freed before they are fit to use in furniture.

881. *Goose feathers are the best for beds*, and are generally employed, being the most elastic. They are usually sorted into white and gray; the latter are cheapest by sixpence a pound, but are equally good for beds as the white.

The best goose feathers come from Dantzic and Hamburg; they bear the highest price, and are most esteemed for their strength and elasticity. Of our feathers, those of Somersetshire are reckoned the best; and the Irish are generally the worst. Irish feathers, it is said, are sometimes adulterated with lime to increase the weight: a small quantity of lime is often sprinkled among the feathers, in order that, by combining with the oil, it may prevent it from turning rancid and injuring them; but the Irish peasantry put a greater quantity than is necessary.

It has been stated that, in some parts of Britain, as in Lincolnshire, geese are plucked five times in the year; the first time, at Lady Day, for feathers and quills; and four times more, for feathers only, between that time and Michaelmas. In cold seasons many geese die by this barbarous custom. In Lancashire they are plucked twice. When killed, each goose yields about a pound and a half of feathers.

882. *Poultry feathers*, as those of the turkey, ducks, and fowls, are soft, but not so elastic as those of the goose. It is difficult to deprive duck's feathers of the odour of the oil which they contain in abundance, and which, if not removed, is highly pernicious, collecting small insects that destroy the feathers.

883. *Down* is furnished by the goose, and more particularly by the swan, of which a good deal comes from Dantzic; but the finest down is from the eider duck, imported into this country from Denmark, and brought from Greenland, Iceland, and Norway. It is used only as a covering to beds, and never should be slept upon, as it thereby loses its elasticity.

884. *Feathers or down, intended for use, should be plucked as soon as possible after the bird is dead*, and before it is cold; otherwise they are defective in that elasticity which is their most valuable property, and are liable to decay. The bird should, besides, be in good health, and not moulting, for the feathers to be in perfection; and when plucked, and a sufficient number collected, the sooner they are dried upon the oven the better, since otherwise they are apt to heat and stick together.

885. *Feathers are prepared for beds* by respectable manufacturers in the following manner: First, all the tail and small wing feathers are picked out; of these there is generally a considerable quantity, and, if suffered to remain, they will injure the softness and elasticity of the bed. The feathers are then put into a building made for the purpose, with flues constructed in the same manner as in a hot-house, where a considerable heat is kept up. In this the feathers are turned over frequently, and a small ventilator at the top suffers the foul vapours to escape. After they have been sufficiently stoved, they are placed in a large cylinder made of loose canvass, which is turned with great velocity by means of the multiplying cog wheels of a horse or hand mill; by these means all the sand and dirt is got rid of. They are then put into linen bags, and beaten, to clear them from the very fine powder or dust that adheres to them. The whole process of cleaning is attended with a loss of one pound in seven of the weight. Much of the comfort and excellence of beds depends, not only upon the quality of the feathers, but upon the operation of cleaning them having been properly performed. In feather beds got up cheap by inferior upholsterers, the feathers are not well freed from the animal oil, and are imperfectly stoved and beaten; in consequence of which they soon harbour insects, and fill the bedchambers with dust and flue, besides emitting an odour that is disagreeable and unwholesome. But it will sometimes happen, even when the feathers have been prepared with great care, that, when quite new, they may have a faint smell when first slept on. To deprive them of it, take off all the blankets every morning, and expose the beds to the air for three or four hours, and in a short time all smell will disappear: for want of this precaution it might remain for several weeks.

886. *The following process of cleaning feathers from their oil* will be a remedy for the above evil, and will likewise supply a method of preparing them for putting into beds. It was communicated to the Society of Arts by Mrs. Jane Richardson. "Take for every gallon of clean water, one pound of quicklime; mix them well together, and when the undissolved lime is precipitated in fine powder, pour off the clear limewater for use. Put the feathers to be cleaned into another tub, and add to them a quantity of clean limewater, sufficient to cover them about three inches, after they have been well immersed and stirred about therein. The feathers, when thoroughly moistened, will sink down, and should remain in the limewater three or four days, after which the foul liquor should be separated from them by laying them on a sieve. The feathers should

be afterward well washed in clean water, and dried upon nets, the meshes of which may be about the fineness of cabbage nets. The feathers must be, from time to time, shaken upon the nets, and as they dry will fall through the meshes, and are to be collected for use. The admission of air will be serviceable in the drying. After being prepared as above, they will only require beating to get rid of the dust." We ought to observe, however, that, notwithstanding the publication of this process, some consider the use of limewater as bad, as the feathers can never afterward be freed from white dust.

887. *The chemical composition of feathers* agrees nearly with that of hairs, consisting of inspissated albumen, mixed with a very minute portion of gelatin, and a little animal oil; but they contain much less mucilage, and receive less moisture from the body. Although feathers are so dry, even when attached to the living bird, they lose much of their pliancy and freshness after being some time plucked.

888. *Feathers intended for dress* are prepared by the *plumasier*. The feathers he employs are those of the ostrich, heron, peacock, swan, goose, and cock. We shall content ourselves with describing the mode of preparing those of the ostrich, which are the principal. The feathers of the male bird are the whitest and most beautiful. Those upon the back and above the wings are preferred; next, those of the wings; and, lastly, those of the tail. The down is merely the feathers of the other parts of the body, which vary in length from four to fourteen inches; it is black in the males and gray in the females. The finest white feathers of the female have always their ends a little greenish, which lessens their lustre, and lowers their price. These feathers are imported from Algiers, Tunis, Alexandria, Madagascar, and Senegal.

They are first scoured in soap and lukewarm water for five or six minutes, and afterward rinsed in hot water. To bleach them, they are immersed in hot water mixed with Spanish white, and well agitated in it: they are then washed successively in three waters. They are next passed rapidly through a bath of cold water, containing a very little indigo; and next sulphured in the same manner as straw hats. The ribs are scraped with a bit of glass, cut circularly, in order to render them very pliant. By drawing the edge of a blunt knife over the filaments they assume the curly form so much admired.

889. *Cleaning and dying feathers* is likewise the business of the plumasier. The original pure white of feathers can never be completely restored when once soiled; but it may sometimes be desirable to give them an artificial colour. The spirituous tincture of turmeric will give them a fine yellow of any depth that may be necessary, and a little lemon juice will brighten the colour. Blue of any shade may be given by liquid blue, or by any sulphate of indigo. Green may be produced by a mixture of the two last dyes for blue and yellow. Buff colour may be produced by adding to a little pearlash a decoction of annotto in water. Red is produced by wetting the feathers with lemon juice, and then with the carmine sold in saucers. Purple is obtained by a mixture of the red and blue dyes.

890. *It has lately been found that a feather, damaged by crumpling, may be perfectly restored by immersing it in hot water.* The feather will thus completely recover its former elasticity, and look as well as ever it did. This fact was discovered accidentally by an amateur ornithologist at Manchester, and may, perhaps, be usefully applied by the plumasier. Having received some skins of birds from South America, he found that the feathers in the tail of one of the rarest specimens had been rumpled in the packing. Accidentally he let the bird fall from his hands into his coffee cup; but instead of its being completely lost, as he at first supposed, having laid it down before the fire to dry, he was agreeably surprised to find that the plumage had been restored to its original straightness and perfection.

SECT. XV.—CAOUTCHOUC, OR INDIA RUBBER.

891. The material called *caoutchouc*, now so much employed in various articles of dress, was for a long time known only in the fine arts by the name of *India rubber*, so useful in obliterating the lines made by a black-lead pencil. The first mention of it which we find is in the preface to Dr. Priestley's "Familiar Introduction to the Theory and Practice of Perspective," printed in 1770, where there is the following notice: "Since this work was printed off, I have seen a substance excellently adapted to the purpose of wiping from paper the marks of a black-lead pencil. It must, therefore, be of singular use to those who practise drawing. It is sold by Mr. Nairne, mathematical instrument-maker, opposite the Royal Exchange. He sells a cubical piece, of about half an inch, for three shillings; and he says it will last several years." How long before that its use in the fine arts had been discovered we do not know; but before the date mentioned, crumb of bread had been used for the purpose alluded to. It is said, however, that the knowledge of this material was first brought to Europe by the French academicians who were sent to South America in 1730 to make astronomical observations.

892. *Caoutchouc*, or India rubber (the latter name having been given to it from the

application we have just alluded to), is originally a white milky juice of certain trees or plants, found abundantly in the Brazils, and Quito in South America, and also in several parts of Asia and Africa. The chief plants which produce it are *Hevea guianensis*, *Jatropha elastica*, and *Urceola elastica*, but particularly the first. These plants grow so extensively in some places, that hundreds of miles are covered with them in a wild state; thus there is no fear of the material falling short of the demand. The juice is procured by making incisions in the tree. For a short time it continues liquid, but soon becomes solid by exposure to the air; and this is the condition in which we usually receive it. The South American Indians prepare of it a variety of useful articles, as water bottles, shoes, boots, &c., by making moulds of clay, and of the shapes required. These they fix to the orifice made in the stems of the trees, so as to permit the juice to flow out and cover them all over with a thin coat. In this state it is held over the fire to dry, and hence its black colour, from the smoke. When it is dry, it is covered with another coat of the juice, which is also dried, and so on, till sufficient thickness is obtained. The clay is then removed from the inside by breaking it into fine powder, or moistening it, and permitting it to pass out at the neck of the bottle. In this way are made the small India rubber bottles which we see in the shops.

893. *Caoutchouc, when fresh taken from the tree in a liquid state*, is of a dirty white colour, resembling in consistence and appearance buttermilk or cream, and it will keep in this state, if not exposed to the air, for two or three months, at the end of which time it coagulates, and becomes thick and solid. Some of it has been imported of late.

Although the juice in its recent state can thus be easily made to produce any form required, yet, as it is perfectly insoluble in water when once it has become solid, it cannot be manufactured into various articles by any ordinary means; these are, therefore, most easily made where the plant grows.

894. *Though warmth softens solid caoutchouc a little*, and heat will cause it to melt, yet, after being rendered liquid in this manner, it does not return to its former condition, but remains always clammy. This singular material was found to resist most of the usual chemical agents employed for dissolving substances. Alcohol does not dissolve it; turpentine acts upon it, but imperfectly; and ether was the only substance that for a long time was known to effect a solution that would afterward become solid upon the evaporation of the menstruum. This solvent is, however, too expensive for ordinary purposes; and is liable to another objection from its great volatility, which does not permit spreading the solution as a varnish properly.

895. *Caoutchouc dissolves partly in some of the essential oils*, as oil of turpentine; and also in the fat oils, as that of olives and of almonds. It may be dissolved by boiling in spirits of turpentine, and putting in small pieces till dissolved; but the solution does not dry perfectly. If half the quantity of drying linseed oil be added, and both boiled together for half an hour, a varnish will be made, impenetrable to water, but which does not dry completely. This was tried for making water-proof cloth; but it did not answer well. By means of this substance the varnish for balloons is made.

896. *It was afterward discovered by Mr. James Syme, lecturer on surgery in Edinburgh, that real naphtha dissolves it readily*, and that it may be recovered from this solution without loss of its elasticity. Naphtha from coal-tar is equally efficacious; and, as this solvent is cheap, the solution of caoutchouc is now applied to numerous useful purposes. When acted upon by naphtha, caoutchouc swells to thirty times its bulk, and then, if worked with a pestle, and pressed through a sieve, it affords a varnish which may be spread upon cloth by means of a flat edge of metal or wood. Two cloths being thus covered, are put together, and passed under a rolling press. The double cloth is then hung up to dry, and to get rid of the smell of the naphtha. This is the method of manufacturing the water-proof cloth now so extensively prepared under the name of *Mackintosh*, and for which there was a patent, now expired.

Great elasticity is one of the most remarkable properties of India rubber, and a strip may be drawn out into forty or fifty times its former size, and yet return to its first dimensions. From this property it is employed in many articles of dress, and likewise in transferring impressions from copper plates to earthenware. When in a softened state, it can be rolled or pressed into sheets thinner than bladder, which are now employed in various manufactures. Such is its power of distension, that a small piece the size of a walnut, when softened by boiling for an hour or two in water, can be blown out into a ball fifty inches in diameter; and in this way are made the *balloons* sold at present as toys.

Caoutchouc tubes for various purposes are now made, which combine perfect flexibility with impermeability to air. These are extremely useful for surgical and other purposes. Another useful application of this material is in Brockenden's stoppers for bottles or decanters. These consist of some substance made to the shape of a stopper, and covered with a piece of sheet India rubber, which, by its elasticity, closes the aperture more effectually than any other method. (See farther, "Elastic Fabrics and Water-proof Cloth," Chap. VIII., Book XVII.)

897. *A new liquid has been prepared from caoutchouc, called caoutchoucine*, which has

singular and useful properties. It is a solvent of all resins, particularly copal, which it dissolves without heat, at the ordinary temperature of the atmosphere, a property possessed by no other solvent known; and hence it is peculiarly useful for making varnishes in general. It also mixes readily with oils, and will be found to be a valuable and cheap menstruum for liquefying oil paints; and without in the slightest degree affecting the most delicate colours, will, from its ready evaporation, cause the paint to dry almost instantly. Cocoanut oil, at the common temperature of the atmosphere, always assumes a concrete form; but a portion of this caoutchoucine mixed with it will cause the oil to become fluid, and to retain sufficient fluidity to burn in a common lamp with extraordinary brilliancy. It is to be observed, however, that this last property is rather curious than useful, as its expense is too great for such application. Caoutchoucine is extremely volatile, has less specific gravity than ether, or any other known liquid; yet its vapour is so heavy, that it may be poured, without the liquor, from one vessel into another, like water. We should notice, that its volatility and the inflammability of its vapour are so great, that care should be taken not to bring a lighted candle near to it when the vessel is opened which contains it. It is procured by cutting caoutchouc into pieces, putting them into a still, to which the heat of 600° is applied. The caoutchouc melts and rises in vapour, which, being condensed by a worm in the usual way, affords the caoutchoucine.

Sect. XIV.—METALS.

Subsect. 1.—*General Observations.*

898. The metals are all simple substances: that is, not compounded of others; but each exists in itself as a separate or unalterable body, apparent alterations consisting always, not in that of the metal itself, but in the addition of some other substance, by which the appearance and properties of the metal are changed. What is called the *rusting* or *tarnishing* of a metal, which is one of the most common changes it is subject to, consists in the addition of oxygen to the metal, the new compound being termed an oxyde in some cases, which is only another word for rust, in common language. Most metals are subject to this change; but a few, as silver, platinum, and gold, are not liable to rust, and have therefore a peculiar value in making coin and plate. There are, in all, forty-one metals distinct from each other; but some of these are extremely rare, being scarcely applied to any use; others are seldom or never employed alone, but only in combination. It will, therefore, be necessary to describe a few only as simple metals. These are platinum, gold, silver, copper, iron, tin, lead, zinc, and quicksilver; and we shall confine ourselves to the description of such of their properties as are important to be known in domestic economy.

Subsect. 2.—*Platinum.*

899. Platinum, resisting the action of most chemical agents, would be a metal extremely valuable for domestic purposes, were it not so expensive in consequence of its rarity. It is of a dull silvery white colour, possessed of considerable lustre, and not at all liable to tarnish or be oxydized. It is likewise the most difficult to fuse of any metal, requiring for this purpose the most intense heat that can be produced, and it is capable of being wrought by the hammer, and rolled out into very thin sheets; it is likewise very hard, and is not acted upon by any of the ordinary acids. From these properties, it is easy to see how invaluable it would be for culinary vessels, did the expense permit. It is, however, occasionally employed for chemical vessels, and even found economical, from its great durability. It is said that, on the Continent, they have succeeded in applying it to copper instead of tinning.

Subsect. 3.—*Gold.*

900. Gold is valuable, not only on account of its scarcity, which renders it very useful as a medium of exchange, but it possesses some peculiar properties which render it preferable to every other metal for particular purposes. Its great malleability is exemplified in the making of gold leaf, so much employed in gilding. Its ductility and tenacity are shown by the drawing of gold and gilt silver wire, and in gold lace and embroidery. Its softness renders it easy to be worked into various delicate forms for ornaments, for which its beautiful rich colour and resplendent lustre, which are different from those of any other metal, peculiarly qualify it; and its perfect unalterability, when exposed to the air or fire, has justly stamped its high character in all ages. Its specific gravity is greater than any metal except platinum. Its hardness is greater than that of lead and tin, but inferior to iron, copper, platinum, and silver. It cannot be dissolved by any acid except the nitro-muriatic, formerly called aqua regia, and which is a mixture of the nitrous and muriatic acids; neither of these acids, separately, can dissolve it; and it is precipitated from its solution in the state of gold powder by an alkali. It forms alloys with most of the metals. These properties render it invaluable for many economical purposes, which are well known; and its never tarnishing, if pure, when exposed to the air, occasions it to be so much used in gilding, both on wood and metals.

SUBSECT. 4.—*Silver.*

901. Silver is a metal not oxydised by the ordinary means, and therefore is perfectly harmless when made into vessels for preparing food. Its expense alone prevents its being employed for all culinary vessels; it is, however, used in these sometimes for particularly nice purposes. Not being acted on by the acetic acid, as iron is, knives for cutting fruit are made of it. Though it is not oxydized by exposure to the air, its surface becomes gradually tarnished, and, in long time, even blackened: this arises from the union of sulphur with the silver, the resulting sulphuret of silver being of a blackish colour. The sulphur is derived from a portion of sulphuretted hydrogen, which is generally present more or less in the atmosphere, and more particularly when the air is impure. Pure water has no effect upon silver; but if the water contain animal or vegetable matter, it often blackens the surface, in consequence of the sulphur it may contain. The well-known blackening of a silver spoon by a hard-boiled egg is owing to the sulphur which all eggs contain in the yolk. Silver is dissolved readily by nitric acid, forming with it a highly corrosive substance, lunar caustic, or nitrate of silver, used as marking-ink. Though a hard metal, silver yields to the knife, but not nearly so easily as tin, which is the metal that comes nearest in resemblance to it. Silver is next in malleability to gold, and is capable of being rolled out and beaten into leaves of extreme thinness; it is so ductile that it may be drawn out into wire as fine as human hair. It is difficult of fusion, but may be melted and cast into moulds. It has been proposed to line the insides of sauce-pans and stew-pans with silver rolled out into thin sheets: these linings might be loose, by which they could be taken out to be mended. Plating copper with silver is a less perfect mode for that purpose, as the thickness of the plating cannot be easily examined. Electro plating copper vessels is now practised. There are several alloys which have been made to assume the improper names of silver, as German silver, nickel silver, &c., in which there is not a particle of this metal; and such names serve only to delude the public. It is to be observed that there can be but one kind of silver; and the same observation may be applied to every other metal.

SUBSECT. 5.—*Iron.*

902. Iron is the metal most abundantly employed for economical purposes; and, fortunately, it is the most plentiful in nature: on account of its great importance and usefulness, it demands particular notice.

903. *Iron is procured from the ores dug out of the earth* by fusing them in a furnace at a very strong heat; the metal, thus freed from the earth with which it was combined in the ore, flows out in a liquid state.

904. *This first product is called cast iron*, because it can be run or cast into moulds. All articles of cast iron are formed by first making models of them in wood, wax, or some other substance; these models are then pressed into very fine sand, and the impression so made is called a *mould*, into which the fluid iron is run from the furnace. But this cast iron is very far from being pure iron. It is iron combined with some carbon, or charcoal, besides various earthy impurities. It differs from pure iron in being crystallized, in not being malleable, or capable of being extended by the hammer; and it is likewise extremely brittle; but it is very hard, and, except made in a particular manner, cannot be cut by a file; consequently, all articles of cast iron are liable to be broken by a blow or fall, or by throwing water upon them when heated. Its fusibility, however, is a valuable property, since many articles of furniture can be made of it by casting, as saucepans, fenders, and ornaments of various kinds, that could not be fabricated in this manner of pure iron, since this cannot be melted in any ordinary degree of heat, even of a furnace.

It must be observed, that, by late improvements in the manufacture of iron, cast iron can be made so soft as to be filed with considerable ease after it is cast into moulds: a circumstance of the greatest importance in fitting together the various parts of castings.

Great quantities of various kinds of cutlery are made of this kind of cast iron, particularly forks, scissors, snuffers, &c. The models are made of lead, and the moulds are in sand. The iron employed is of the kind which contains a large quantity of carbon, fuses at a low temperature, and becomes very liquid. It is the only kind that can be used for small articles; these, when cast, are almost as brittle as glass; but, to obviate this, they are afterward heated in pots with ashes or sand for the purpose of annealing them. After this process, they are found to be very soft, and to be capable of even bending a little without breaking. They are then finished in a manner similar to those that are forged, with the exception that they are not hardened and tempered; were they subjected to that process, they would return to the same state as before annealing. Cutlery made in this manner is sold at a very low price; but the knives and forks are not only liable to break, but they soon turn blackish, and then can be very little improved by the common mode of cleaning; they are susceptible of only a very miserable polish.

Various attempts have been made with a view to improve the cast iron cutlery, some of which have been rather successful.

905. *The art of casting iron is carried to a great degree of perfection in Prussia.* Ornaments made of cast iron *come to us from Berlin* that are quite surprising for their delicacy and beauty; not only figures, candlesticks, lamp-stands, ink-stands, &c., but necklaces, ear-rings, broaches, and similar ornaments. These have of late been imitated here with tolerable success; but it is said our founders are not acquainted with the Prussian method of staining the iron with a deep black that never wears off: they can only apply a thin varnish that is liable to come off.

906. *Pure, or malleable iron, called also wrought iron, is manufactured from cast iron* by reheating masses of it, called pigs, and subjecting them to the action of a heavy hammer worked by powerful machinery. By heating and hammering repeatedly these pigs of crude or cast iron, the carbon is expelled, and the metal at last is obtained in a state of purity, when it manifests its well-known properties of great ductility or malleability, by which it can be fashioned into various articles by the smith, although it has become very infusible, and cannot be melted in the ordinary heat even of a furnace. It can now be *welded;* that is, two or more pieces of iron, when heated intensely, can be made to adhere and unite together under the smith's hammer: a property of very great value not possessed by cast iron. In this state it is likewise so soft that it can be subjected to the file, and made into any form. Hence, wrought iron is employed for many domestic implements, in the fashioning of which filing is necessary, except where brittleness would be a great objection, as fire-iron, and various things forged by the smith: but it rusts easily when exposed to damp air, and does not take a high polish. Wrought or malleable iron is not sufficiently hard for making cutting instruments; for this purpose, it must be converted into steel.

907. *Steel is an artificial combination of iron with carbon,* though somewhat different from that which composes cast iron. When steel is made red hot it is soft, and can be hammered and filed into any shape; but if suddenly plunged, in its heated state, into cold water, it instantly becomes extremely hard, and can no longer be acted upon by a file, which is itself steel so hardened, and has the power of cutting and piercing iron or steel before it is so hardened. Steel is likewise brittle, and no longer yields to the hammer; and it is extremely elastic: hence it is employed for making springs; it takes the most beautiful polish, and it is then less liable to rust than iron.

Steel might, however, be too hard and brittle for many edge tools, and, therefore, after this process of hardening, most tools and instruments go through another process called *tempering,* which is letting down or reducing the hardness to the degree just proper for the instrument, and thus giving it a certain firmness and toughness.

908. *The tempering of steel instruments* is effected by heating them again to a certain point, and plunging them into cold water, or some fluid, as mercury or oil. Steel, when tempering, assumes various colours with different degrees of heat. At 430° it appears of a pale yellow; with a higher degree of heat it becomes brown; and by increasing the heat, it appears at last of a beautiful blue. Giving the temperature proper for each kind of cutting instrument is a very delicate operation, and is managed with great nicety by the cutler.

There are several kinds or qualities of steel in common use; to explain which, we must describe briefly the process by which iron is converted into steel.

909. *To convert iron into steel,* bars of soft iron are put into a particular kind of furnace, in layers, with powdered charcoal between each layer, and the whole is covered up close with a mixture of clay and sand, so as to prevent the access of atmospheric air. A strong heat is then applied for eight days, and the furnace is then suffered to cool; in about eight days more it is sufficiently cooled, and the bars of iron are thus found to be converted into steel. The explanation of the conversion of the iron into steel is this: the iron, at a high heat, absorbs carbon from the charcoal put between the bars, and forms a chemical combination with it, steel being iron and carbon. This mode of making steel is called *cementation.* As the bars, after this process, always appear blistered on the surface, they are called *blistered steel.* These bars are then hammered into rods of various sizes, and are sold as *common steel,* of which all kinds of forks and cheap cutlery are made.

910. *Tools which require great tenacity without great hardness,* such as table knives, scythes, plane iron, &c., are made of what is called *shear steel,* so named, because first employed in making wool shears. Shear steel is made by laying a number of bars of blistered steel together, heating them to a welding heat, and working them together into bars by a forge hammer. This forms a tough steel free from flaws.

911. *All the fine articles of cutlery,* such as razors, the best penknives, scissors, and instruments required to have a high polish, are made of *cast steel.* Cast steel is made by fusing blistered steel in covered crucibles, and pouring it into cast iron moulds, so as to form it into ingots; these ingots are afterward drawn into bars or rods of suitable dimensions. Formerly this kind of steel could only be worked at a very low heat; but it can now be made so soft as to be welded to iron with the greatest ease, which saves the expense of making certain articles entirely of steel, the edge part only requiring to be of this material.

Wootz is a species of steel manufactured in India only; and as it admits of a higher temper than our steel, it has been imported for making razors and surgical instruments, for which it answers admirably, though it does not appear to be certain that it is superior for these purposes to our best cast steel. It is not known accurately in what manner it is produced from the ore, but it is supposed to be a natural steel.

912. *Silver steel, and Peruvian steel,* are also names which we see announced as designating metals of superior qualities, but without any good reason.

913. *The discovery of steel* is, perhaps, second in importance to few of those which man has made; for it has given him all the best edge and cutting tools by which he has moulded almost every other substance to his wishes. A savage will work for twelve months with fire and sharp stones to fell a great tree, and to give it the shape of a canoe, which a modern carpenter, with his tools, could accomplish in a few days. So manageable has steel become, that it can be softened sufficiently to admit of being engraved on like copper; and it is afterward hardened, by which the plate so produced can give ten times as many, or more, impressions than a copper plate before it is worn out.

914. *Iron is perfectly harmless, when employed in culinary vessels.* Its rust or oxyde, so far from being hurtful, is frequently prescribed as an excellent tonic; and the only inconvenience arising from employing the metal in its pure state is its liability to rust, thus wearing into holes; and, in this case, it is likewise apt to tinge the colour of food prepared in it. On this account, sauce-pans, tea-kettles, and other utensils made of iron are tinned over, to prevent rusting. Cast iron is much less apt to rust than hammered or rolled.

915. *There is one precaution by means of which the disagreeable effects produced by this metal on food, when it rusts, may be very much diminished,* and, indeed, in most cases almost entirely prevented, especially when the utensil is made of *cast iron*. If, instead of scouring the inside of such boilers and stew-pans with sand, they be simply washed and rinsed out with warm water and wiped with a soft cloth, the surface of the metal will soon become covered with a thin crust or coating of a dark brown colour, resembling enamel: which covering, if it be suffered to remain and to consolidate, will at last become so hard as to take a very good polish, and will serve, very efficaciously, to defend the surface of the metal from farther corrosion, and consequently to prevent the food from acquiring that taste and colour which iron alone is apt to impart to it. The process by which this covering is gradually formed is similar to that by which some gunsmiths brown the barrels of fowling-pieces, and would, no doubt, be greatly expedited by the same means which they employ for that purpose: the object had in view is likewise the same in both cases, by causing a hard and impenetrable covering of rust to be formed on the surface of the iron, to defend it from contact with those substances which are capable of dissolving or corroding it, or, in other words, to prevent the farther progress of the rust.

SUBSECT. 6.—*Copper.*

916. Copper, from its malleability and ductility, as well as hardness, is extremely useful in articles of domestic economy. It suffers little change in a dry atmosphere, but in moist air it rusts, and is converted into a carbonate of copper, which is oxyde of copper united to carbonic acid, being of a green colour. It is remarkable that, though copper is oxydized by sulphuric or muriatic acids, and by the vegetable acids, in the air, yet if air be thoroughly excluded, these acids do not attack it. All the oxydes and salts formed by copper are violently poisonous; yet metallic copper is not so; copper coins swallowed by persons have lain in the intestines for months without any inconvenience.

917. *Copper is easily acted upon by the acetic acid* or vinegar, and a green substance is formed, well known by the name of *verdigris;* which is an acetate of copper, or acetic acid united to oxyde of copper, the poisonous nature of which is generally known: it is a powerful direct emetic, producing vomiting as soon as it is swallowed, without exciting nausea.

918. *Copper is likewise acted on by fat and oil of every description,* and carbonate of copper is thus formed: therefore, when copper vessels have been used for preparing food, fat should never be suffered to remain in them: many cases of poisoning are known to have happened from soup or fat broth having been left for some time in copper boilers.

919. *Chemists and physicians have repeatedly pointed out the danger arising from the use of copper vessels in culinary operations;* and numerous cases have been cited where this deleterious metal is suffered to enter into our food and drink; some of which, however, appear more alarming than is perhaps necessary. Thus it has been observed that the brewer boils our beer in copper vessels; the sugar-baker employs copper pans; the pastry-cook bakes our tarts in copper moulds; the confectioner uses copper or brass vessels; the oilman boils his pickles in the same. Though the quantity of copper thus introduced into our food and drink is not so great as to produce sudden fatal effects, yet it is not improbable that it may be sufficient to cause, in the course of time, derangements of the system. The senate of Sweden, in 1753, was so much impressed with the importance of the subject, that they prohibited the use of copper vessels for culinary

purposes, and ordered that none but such as were made of iron should be employed in their fleets and armies.

Confectioners rarely make use of any other vessels than those of copper untinned, even in the preparation of acid sirups, as of oranges and lemons; but they take care that these vessels are well scoured, and kept perfectly clean; also, that the sirups remain in them no longer than is absolutely necessary. Some preserving pans are made of brass and bell-metal; and these are preferable to copper.

920. *Tinning on the inside prevents copper utensils from having the poisonous effect they would otherwise have* upon food if prepared in them. Copper boilers, sauce-pans, and other things of this kind, are not made of copper *previously* tinned, as in the case of iron, but they are tinned-*after* they are made. They are first scoured bright, and then made hot, and the tin is rubbed on over the fire with a piece of cloth, or some tow, having first sprinkled the surface of the copper with some powdered resin, oil, pitch, or some other inflammable substance, the use of which is to reduce such part of the tin to the metallic state as may happen to be oxydated; for, as we observed in the case of tinning iron, it is essential that both the metal and the tin should be in the pure, and not in the oxydized state, in order that they should unite. If the copper were tinned first, the tin would be melted off by the heat required by the hard solder used in making the joints. In this process nothing ought to be used but pure grain tin; but we are sorry to observe that lead is sometimes mixed with the tin, to adulterate its quality, and to make it lie more easily. This is a pernicious practice.

921. *All copper vessels, as soup-kettles, stew-pans, &c., should be examined every time they are used*; these, as well as their covers, should be kept well tinned, to prevent those accidents which are so liable to occur from neglect; and no food should be suffered to remain in them any longer than is necessary for its preparation for the table.

922. *It is stated as an interesting chemical fact, that copper cannot be dissolved by acids while tin is present.* If a copper sauce-pan be so worn that part of the tinning is off, the acids take up some of the tin and deposite it on the abraded part, thus repairing, in some degree, the damage; in the same manner as brass pins are tinned by boiling with tin filings and cream of tartar. It is said, also, that no verdigris is formed in copper vessels while the substances they contain are in a state of actual boiling; and that it is only when the acids are cold, or, at least, not boiling hot, that they corrode the copper; but it is best not to trust to any chemical facts of that kind, but to have all copper well tinned, as the safest practice.

923. *Although copper may be, and to a considerable extent is, cast in sand*, like other metals, it is in the state of sheets rolled out that the largest consumption takes place. It is an easy and pleasant metal to hammer, being at once soft and tenacious. These sheets, when cut into the desired form, are united by hard solder, and thus formed into various utensils. The hard solder employed is composed of three parts of brass and one part of zinc, being more fusible than common brass. A copper tea-kettle presents a familiar, but ingenious specimen of the coppersmith's art, both with reference to soldering and hammering; taken, indeed, in all its parts, it exhibits the result of almost every operation of his workshop. Most of the parts are cut out of sheet copper, and soldered up; the spout is formed by filling a tube with lead, and hammering it upon a mandrel; and the lid is stamped. Copper tea-urns and sauce-pans are formed by soldering and hammering in a similar manner, the brown colour of the former being produced by the application of sulphate of copper, or Roman vitriol, previous to the planishing and burnishing.

924. *Attempts have been made to line copper culinary vessels with tinned iron*, in order to guard against the poisonous qualities of the copper; but the tin was then found to rust with uncommon rapidity, owing to a galvanic effect between the two metals; and it is observed that, in cases where iron is riveted to copper, the rivet holes are acted upon in a similar manner, which causes the iron to loosen.

SUBSECT. 7.—*Lead.*

925. *Lead is a metal, fortunately, too soft, by itself, to be used for culinary vessels*, otherwise it would prove very dangerous, since all its salts produced by acid substances are more or less poisonous, and some of them highly so. It is readily dissolved by the acetic acid or vinegar which exists in all acid fruits, and the result is *acetate of lead*, or sugar of lead; although this is scarcely a poison of itself, yet it may be converted, when in the stomach, into the carbonate of lead, which is a deadly poison. It is not safe, therefore, to admit into the human constitution any of the salts of this metal, in any form whatever, except, as in medical practice, it should be administered with certain correctives of its poisonous qualities. It is supposed that lead, in its metallic state, like all other metals, is probably inert; but it is so easily acted upon by even the weakest acids and alkalies, that its presence in the stomach can never be free from danger. Of all the salts of lead, the *carbonate* is the most virulent poison. When metallic lead is exposed to the air, it soon acquires upon its surface a thin white coating, which is a carbonate of the metal. When lead is exposed to the action of rain-water and air, the

same kind of white powdery crust is formed; and this appears just at the surface line of the water in leaden cisterns, when the water has been suffered to remain long. Rain-water, collected from the roofs of houses where there are leaden gutters, and coming down through leaden pipes, and in similar cases, when water and lead have been long in contact, holds always more or less of this poisonous salt. Sulphuric acid does not act upon lead when cold, but when hot it dissolves that metal.

926. *Although lead is not much used in vessels for preparing or holding food, yet there are several cases in which its improper use may be pointed out.* In some parts of the country it is, or was, the custom to keep milk in leaden vessels, particularly in Lancashire, from a mistaken idea of its cleanliness and coolness; but the consequence is, that the acid of the milk dissolves a portion of the lead, which is thus converted into a dangerous substance; and though the quantity may be small, yet, long continued, it may produce disease.

Vats of lead have been used in some cider countries, and have produced incalculable mischief. What is called the Devonshire colic is occasioned by this practice, and is identified, by its effects on the system, with the colic of the plumbers, painters, and white-lead makers.

Brewing coppers, in some places, have their bottoms only of copper, their sides being of lead; these are dangerous, as the lead must be more or less dissolved by the wort. The glaze of some kinds of earthenware is made with oxyde of lead, and is improper for pickling vessels.

927. *The poisonous effects of lead are sensibly felt in white-lead manufactories*, where the air breathed by the workmen is, in some degree, impregnated with it; and house-painters, who are continually inhaling vapours containing some of this, and having their hands and clothes stained with it, are frequently attacked with a peculiar disease, termed the painter's colic.

928. *Lead can be plated with tin*, and as the latter metal is much less deleterious than the former, this method is sometimes resorted to in pipes. To effect this, heated lead is rubbed with melted tin, using, at the same time, turpentine, or some other resinous matter, as a flux. The lead being thus covered with tin, any quantity of the latter metal will readily adhere to the surface of the cylinder of lead, which is then ready to be drawn into pipes. This useful process, however, we believe, is not much practised.

SUBSECT. 8.—*Tin.*

929. *Tin* is a metal of a white or more silvery colour than lead, and it is somewhat harder. Nearly the whole of our tin is procured from the tin mines in Cornwall, where the masses of the metal, made ready for sale, are termed *block tin*; and a purer kind is called *grain tin*.

930. *The metal tin, by itself, is sometimes employed for making certain vessels*, as boilers for dyers, worms for stills, and for other purposes in the arts, but it is never formed into kitchen or culinary utensils.

931. *What is usually called tin*, when employed for articles of this kind, as sauce-pans, tea-kettles, &c., is, in fact, sheets of iron coated over, or plated with tin; this is a material so very important, and so frequently misunderstood, that it will be proper to describe it somewhat at length. We have mentioned the poisonous qualities of copper and brass; and that iron is not unwholesome, but so extremely liable to rust, that it cannot conveniently be employed for the ordinary utensils of the kitchen. Tin does not rust; and it is this property, and the facility with which iron is coated with it as a protection, that occasions it to be so much employed.

932. *The forming of tin plate is one of the greatest improvements in our culinary apparatus.* The process of making is the following: the best iron is rolled out by a flatting mill into plates of the proper thickness, and these are cut by shears into suitable sizes. These plates are first thoroughly scoured with sand to clean off all the black oxyde, and they are then steeped in water, having in it a little muriatic acid, to dissolve what oxyde may remain. They are next hammered, rolled, and steeped again, till they are perfectly bright, and free from black spots, and they are again scoured with hemp and sand, to make them quite ready to be tinned. In order to coat them with tin, an iron pot is nearly filled with this metal in a melted state, and a quantity of tallow or grease, sufficient, when melted, to cover the fluid tin to the thickness of two inches, is put into it. Into this pot the sheets of bright iron are plunged, in order to coat them over. But previously to this, another pot is filled with melted grease only, and the sheets of iron are immersed in it. From the grease pot they are removed, with the grease adhering to them, into the pot containing the melted tin, in which they are placed in a vertical position. About three hundred and forty plates are usually put into the pot at once, and they remain in it an hour and a half: they are then taken out and drained. But when they are first taken out, more tin adheres to them than is necessary; this is taken off by a subsequent process, called *washing*, which is done by passing them through a large quantity of melted grain tin, which operation melts all the loose tin on the surface of the plates, which are immediately brushed on each side, with a brush made of hemp. The

plates are then immersed again for a short time in melted tallow, and are cleaned with bran, ready for sale. It is absolutely necessary that the iron should be quite bright and free from oxyde; and the use of the tallow is to preserve the tin from the action of the air, it being requisite that both metals should be in a perfectly pure state before they will adhere together.

These sheets of tin plate are purchased by the tinman, who cuts them with his shears into the requisite forms, and solders them together to make various utensils, as tea-kettles, coffee-pots, sauce-pans, candlesticks, and similar things to be found in his shop.

933. *We hear it frequently said that certain articles of this kind, as dish-covers, coffee-pots, &c., are made of block tin:* and many persons suppose that such things are made of the pure metal tin *only;* but this is an error: the metal tin will not do to use in this way: it would bend too easily; and all such articles are, as we have observed, made of iron coated with tin. What is sold under the term *block tin*, is only tin plate better planished, and a little stouter than ordinary; but it is singular enough that the term block tin applied to manufactured goods is not used in the tinman's trade, and it appears to be an error which has crept in among his customers, and of which he permits the existence. The terms *single* and *double block tin* mean only tin plate of different degrees of stoutness.

In the ironmongers' shops there are articles of three kinds of tin, known by them under the names of common tin, planished tin, and strong tin. The last two are termed *block tin* by the customers.

934. *The advantages of tin plate for culinary vessels* may be thus enumerated. It resists great heat and changes of temperature, and is not liable to crack like earthenware; it is quickly heated, it is lighter than earthenware, it is not brittle, and can be mended, which the latter cannot be; hence, though dear at first, it is, perhaps, cheaper in the end, if great care be taken of it. It is perfectly clean and wholesome, which earthenware glazed with lead is not.

935. *As the use of tinning iron is to prevent its rusting,* in the same manner as a varnish, it is obvious that whatever wears off the tin lays bare the surface of the iron, and exposes it to the action of moisture and air, which occasions its rusting. It may be easily understood from this, that, to preserve tin sauce-pans, candlesticks, and all other utensils made of tin plate, care should be taken not to wear away the tin from the surface. Every one has seen silver-plated candlesticks which have been cleaned so often that the copper is made visible by wearing away the silvering. This is easily known from the reddish colour of the copper, so different from that of the silver; but many cooks do not know that tin sauce-pans, &c., are only iron plated with tin, and that they are destroyed by frequent rubbing, just as plated candlesticks are. The colour of the tin being so near to that of the iron prevents this from being seen at first. But the iron itself, when exposed, soon becomes black, while the tin preserves its brightness. If the iron so exposed be scoured with sand, it also will become bright, but it never has the silvery colour of the tin, and may be easily distinguished by an attentive eye. As soon as the tin is worn, the iron soon rusts, and gets into holes, which the tinman cannot mend.

936. *To clean covers, or any other article of bright tin.*—Get a ball of the finest whiting (common whiting has generally a little sand); mix some of it powdered with a very little drop of sweet oil, and rub the tin with this; then wipe it clean; after that, dust some dry whiting on it, and clean it off with shamoy leather. To prevent rusting, tin requires to be kept in a dry place; for, though the metal tin is not itself liable to rust, yet there are always some edges or minute places of the iron imperfectly covered, which are sure to rust; and this, in time, will corrode into holes.

Subsect. 9.—*Zinc.*

937. *Zinc has lately been introduced into domestic economy* for vessels of various kinds, and other purposes. The salts of zinc are not so poisonous as those of lead; but they are so to a great degree, and therefore this metal is improper for all purposes where food is concerned. In America, a patent was taken out for an improved milk vessel of zinc, which, it was said, had the effect of "causing the milk to throw up more cream, and to prevent it from turning sour;" but this effect could only be produced by a portion of the metal being dissolved, and forming acetate of zinc, a poisonous salt.

938. *Zinc is very little liable to oxydate in the air,* and therefore it is a useful material for many utensils formerly made of iron or copper. Coal skuttles are now made of zinc alone, or of sheet iron lined with zinc, which are more durable, though dearer, than those of iron; and they are cheaper than those of copper. Zinc is likewise employed instead of lead for baths, as being cheaper, and for pails, rain-water, and other pipes; pierced with numerous holes, it serves for window blinds, for enclosing safes, and many similar purposes: also various cowls for chimney-tops are made of it. Zinc is not malleable when cold, but, heated nearly to the melting point, it can be rolled into sheets with great facility. It has not been in use here in this way above twenty years.

Subsect. 10.—*Quicksilver.*

939. Quicksilver, called also mercury, is so far different from all the rest of the ordi-

nary metals, that it is always fluid in the common temperature of the atmosphere, and can be rendered solid only by exposing it to an intense degree of cold, when it is found to be malleable; but as it retains its solid form only so long as the cold is continued, this fact cannot be applied to any useful purpose. The fluidity of mercury, and its bright lustre, are properties that render it extremely applicable to various uses, as in the construction of barometers and thermometers; likewise in the uniting with tinfoil to form the silvering for mirrors. It is an extremely heavy metal, and does not oxyde readily; but its oxydes are poisons, as well as the fumes of mercury, when it is boiled, which it can be with a very high degree of heat, equal to 600° Fahr.

SUBSECT. 11.—*Alloys of Metals.*

940. *These are compounds formed by fusing two or more metals together;* and it is the more necessary to state this, because the compound receiving a distinct name, many persons are not aware that they are not separate metals, but only mixtures. Formerly the term alloy was confined to compounds formed of gold, silver, and a little copper, used for coin; but now the term means any mixture of metals whatever.

941. *Alloys are formed for various reasons.* Some metals that are too soft, as gold, are alloyed to render them less liable to lose weight by wear. Some alloys are made to procure a hard or tough metal; others for the beauty of their colour; others, again, to prevent oxydation. In short, almost all the mixtures of various metals with each other have particular properties that render them valuable for some purpose or other; and thus the number of the metals appear as if they were increased, although it is not so in fact.

The changes in the properties of metals by alloying are sometimes very remarkable. Thus gold and lead, and gold and tin, metals extremely malleable, form brittle alloys. The alloy of copper and gold is harder than either of its component parts. A minute quantity of arsenic added to copper renders it white. The fusibility of an alloy is generally greater than that of its components. Thus, an alloy of lead, tin, and bismuth, melts with the heat of boiling water.

942. The alloys in common use are,

943. *Standard gold,* which consists of 11 parts pure gold, 1 part copper; of this, 1 pound troy is coined into 46 sovereigns.

944. *Ring, or jewellers' gold:* 1 ounce 5 pennyweights gold coin, 6 pennyweights 12 grains fine silver, and one pennyweight of copper.

945. *Standard silver:* 11 ounces 2 pennyweights of fine silver, and 18 pennyweights of copper.

946. *Brass is a mixture of copper and zinc* in various proportions, but generally in the proportion of seventy-five of the former to twenty-five of the latter. The colour, and some other properties of the brass, vary according to the quantities of copper and zinc, the paler kinds containing most zinc. In some kinds the colour approaches very near to that of gold, and is extremely beautiful. Brass is more fusible, but less malleable, when cold, than copper; and is not only capable of being easily cast in moulds, but can also be rolled out into sheets.

It is less liable to rust and to be acted upon by acids than copper—a property that renders it more useful for cooking utensils; and, before tinned iron came into use, brass vessels were much employed in the kitchen. At present, the superior malleability of copper has almost driven brass out of the field for sauce-pans and stew-pans, though copper is more difficult to clean and more liable to tarnish. These ancient brass vessels were all cast: some are now made of sheet brass.

But, notwithstanding that brass is not so liable to be acted upon by acids and other corrosive substances as copper, this danger is far from being entirely removed, as may be easily seen by the green carbonate of copper which is formed on it by acids, and by fat or oil. Brass vessels, therefore, require the same precautions as copper, and should never be employed to keep food in for any length of time.

Next to iron, brass is the most useful metal in the modern arts and manufactures. As it is variously compounded or alloyed, it is more or less adapted for that amazing variety of purposes to which it is so extensively and profitably applied. When in its purest state from the foundry, it is so soft and malleable as easily to admit of being spread out into sheets under the rollers; and it may be beaten out into tinsel with the utmost facility. Brass in this state admits of being stamped or embossed with a degree of ease which renders it valuable for cheapness and beauty, in numerous useful and ornamental articles. When properly made, it has a considerable degree of ductility and tenacity, and may be drawn into very fine wire: a slight degree of heat will increase its ductility; but, when heated to about 300°, a smart stroke of the hammer will reduce it to powder.

947. *Pinchbeck* consists of 1 ounce of brass, from 1 to 5 ounces of copper, and 1 ounce of zinc.

948. *Tombac* has more copper, and is of a deeper red than pinchbeck.

949. *Manheim gold, or similor;* 3 ounces of copper, 1¼ ounce of brass, 15 grains of pure tin.

950. *Or-molu* is the name given to a particular alloy of 52 parts zinc and 48 copper.

951. *Bronze* is a mixture of tin and copper, sometimes with the addition of zinc; but the proportions vary. It is tougher and harder than copper, and does not rust so soon when exposed to the air; but in time, and particularly by being buried in the ground, it is covered with a dark green rust. It was much employed by the ancients for a variety of purposes: Homer describes most of the arms, offensive and defensive, as brazen, or of bronze, and does not mention steel: most of the arms and instruments found in Herculaneum, Pompeii, Stabia, &c., are of bronze or brass, among which there is even a complete set of surgical instruments. Bronze was also extensively employed for statues, candelabra, candlesticks, lamps, and a great number of domestic utensils and articles of furniture, of which a vast variety may be seen in public museums. No doubt the facility with which it can be cast, and the sharpness of the impression which it receives, together with its great durability, were the causes for its preference. It is at present employed to a considerable extent for similar purposes, although the modern improvements in casting iron, which is a much cheaper material, has superseded the use of bronze on many occasions.

Birmingham is the chief place in England for the manufacture of articles of bronze. But the most extensive manufactory of this kind is in Paris, where there are 250 houses engaged exclusively in it. There every description of chandelier, candelabra, lamps, candlesticks, &c., are made. The number of workmen is estimated at 5000, to which we may add 1000 gilders, who form a distinct body. The manufacture is estimated to produce annually the sum of about 800,000*l*., great part of which is exported. At Paris, there are made every year 15,000 bronze clocks, 40,000 pairs of candlesticks, 3600 pairs of candelabra, and 100 *surtouts de table*, which are large ornamental vases for holding flowers, placed in the centre of the table at large dinner-parties. These articles of French manufacture display great skill and taste, and many of them are seen in the annual exhibition in Paris.

952. *Bell metal* is a species of bronze, consisting of 78 parts of copper and 22 of tin: some bell founders add zinc and lead; but these metals are prejudicial, and are only added to save expense. The *Chinese gongs* are made of an alloy of copper and tin, in the proportion of 78 of the former to 22 of the latter, according to an analysis by Klaproth. They are forged by the hammer, and tempered.

953. *Gun metal* consists of 100 parts of copper and 12 of tin, with or without a little brass.

954. *Tutenag*, called also *white copper*, is a Chinese metal, the method of preparing which is not known in this country; but, when analyzed, it is found to consist of, in 100 parts, copper 2·02, zinc 1·27, nickel 1·58, iron 0·13. It is extremely sonorous, and not easily tarnished. It appears to be very similar to our German silver.

955. The alloys known among us by the names of *German silver*, *nickel silver*, *albata*, and *British plate*, consist of zinc, copper, and tin chiefly, but without any silver, though they are spurious imitations of that metal; and, as each manufacturer pretends to have some peculiar composition or proportions, it is impossible to state these with accuracy. See some observations on them under "Plate," Chap. XVII.

956. *Pewter* is a compound metal, or an alloy of tin, antimony, and lead; but its composition is not always uniform. There are three kinds of pewter in common use, called *plate metal*, *triple*, and *ley*. Plate metal is said to be formed of 112 parts of tin, 6 or 7 of antimony, and a small portion of brass or copper to harden it; it is the best kind, and used for making dishes. The sort termed triple is used for alehouse pots, and is composed of lead and tin, with a little brass. The ley pewter, used for wine and spirit measures, has more lead. Lead being a cheaper metal than tin, it is the interest of the manufacturer to employ as much as he can of the former metal; and, consequently, pewter is apt to contain too much of it.

Lead, being a noxious metal, danger was apprehended from its employment in this way; and the French government appointed a commission of some very able chemists to examine the subject. They found that, when wine or vinegar is allowed to stand in vessels composed of an alloy of tin and lead in different proportions, the tin is first dissolved, while the lead is not sensibly acted upon by these liquors, except at the line of contact of the air and the liquor; and no sensible quantity of lead is dissolved even by vinegar, after standing some days in vessels that contained no more than 18 per cent. of lead. Hence it was concluded that, as no noxious effect is produced by the very minute quantity of tin which is dissolved, pewter may be considered as a safe material when it contains about 80 per cent. of tin; and, where vessels are intended merely for measures, a much less proportion of tin may be allowed. But the common pewter of Paris was found to contain no more than 25 to 30 per cent. of tin, and the remainder was lead: there is reason to fear that this is also the composition of our common pewter; if so, malt liquor, and particularly porter, always containing more or less acetic acid, cannot fail to dissolve some of the deleterious metal.

It has been just stated that vinegar dissolves a very small portion of the lead as well as of the tin, just at the surface of the fluid where the acid is in contact with the metal

and the air; and there may thus be occasionally cases where the dissolved lead may pass into our food and drink: for instance, where vinegar is distilled through a pewter worm, traces of lead, as well as of tin, have been discovered in the vinegar. The use of such pewter as contains much lead, for any vessels where food or drink is concerned, should, therefore, be as much as possible avoided.

957. *Britannia metal*, or *Prince's metal*, has lately come much into fashion, and has superseded the employment of ordinary pewter in a great many articles of common use: this alloy is composed of 3½ cwt. of best block tin; 28 lbs. of antimony; 8 lbs. of copper, and 8 lbs. of brass. It takes a high polish, and does not readily tarnish: when kept perfectly bright it has great beauty, far excelling pewter, and approaching in lustre to silver. A quart teapot of it costs only a few shillings; but from attempting to reduce the price so much, the metal is frequently made so thin as to occasion its being bulged or warped by very slight accidents, or even by the heat of the water. It is also employed for candlesticks, coffee biggins, and measures for liquids. It is not easily acted upon by acids, and is perfectly safe. One of the most valuable uses to which this metal is applied is the manufacture of spoons, which are not only brighter and better looking than pewter, but less apt to bend. There are various qualities of Britannia metal, arising from the introduction of lead into some of it. The principal seat of this manufacture is at Sheffield.

958. *Biddery ware* is made in India, and receives its name from the place of its manufacture, Biddery, a large city about sixty miles northwest from Hyderabad. When its metallic colour is brought out, it resembles pewter or zinc. Dr. Hayne informs us that it is composed of 16 oz. of copper, 4 oz. of lead, and 2 oz. of tin; these are melted together, and to every 3 oz. of the alloy 16 oz. of spelter is added. The people of the East prefer making it black, and inlaying it with silver with great labour; the colour is given by dipping the articles into a solution of sal-ammoniac, saltpetre, common salt, and blue vitriol.

959. *Speculum metal* consists of 32 parts copper, 15 tin, 1 brass, 1 silver, and 1 arsenic.

960. *Type metal:* lead hardened by antimony, with some copper and brass.

961. *Hard solder* consists of 2 pounds copper, and 1 pound tin.

962. *Soft solder:* two thirds tin and one third lead.

SECT. XVII.—SUBSTANCES FOR SCOURING AND POLISHING.

Few things in domestic economy are less understood than these operations, although so much practised.

963. *To remove dirt or discoloration of any kind from the surfaces of various utensils* or other articles of furniture, and to restore the polish they have lost, demands an intimate knowledge of the nature of the materials to be operated upon, as well as of those which are employed in effecting the change; otherwise infinite damage may be done that cannot be remedied. With respect to metallic vessels, it is necessary to know whether they consist only of one metal in the solid, or whether that seen on the outside is merely superficial, as is the case of tinned copper and iron, silver plate, and gilt articles, which may be entirely destroyed by the same process that might be safely used for solid copper, iron, silver, or gold. In many cases the dirt is to be removed from culinary vessels by some substance that will soften or dissolve it, as soaking in cold or hot water; or if oily or greasy, by the use of alkali, or other means sufficiently well known in the scullery. But when recourse must be had to materials that act only mechanically, by grinding or wearing away what is to be removed, attention must be paid to the nature of the mechanical process, to prevent errors and misconceptions. It is necessary, first, to observe that no surface, however smooth, is absolutely so. The difference between a surface which is level or flat, but rough, and one that is smooth and polished, consists only in the magnitude of the inequalities with which they are both covered. When these are visible to the eye, the surface is called rough; but when the inequalities are so minute that none can be seen by the naked eye, we say that it is smooth; and when they are still smaller, so as to be perfectly invisible with a magnifier, and to reflect most of the light in one direction, we say that the surface is polished.

964. *In the commencement of the process of polishing any substance*, they begin by grinding down the surface so as to reduce it to a level, by means of some coarse sandstone, or cutting powder like sand, or emery and water. When the surface is rendered flat, it will be seen covered with an infinity of deep scratches in all directions, made by the powder employed. A continuance of grinding with the same substance would not make the surface any smoother, and therefore a new material for grinding, the particles of which are smaller, is now necessary. This wears down the surface still farther; the former scratches are all obliterated, but the surface is equally covered with scratches, only they are all of a smaller character. As finer and finer powders are employed, so the scratches will be diminished in magnitude, though not in number, until at last, by employing an extremely fine polishing powder, the greatest diminution in the size of the scratches, and consequently the highest degree of polish, is obtained.

965. *This being the true nature of polishing*, it may be readily seen how very essential

it is that the nature of all polishing substances should be well understood, in order to determine which ought to be employed in each particular case, that the process may be effected in the best manner. For example, let us consider the method of polishing any pieces of metal. At first the surface must be got perfectly level, and tolerably smooth, by rolling, hammering, or other mechanical process. Next it must be rubbed with a coarse powder, consisting of hard particles, as sand, or coarse emery, which will scratch it all over, and reduce the general surface to an accurate level. By using finer sand, or finer emery, the size of the scratches will be reduced. After that another powder must be employed, still finer, perhaps washed emery; and next tripoli or rotten stone, which is finer and softer still. To lessen the danger of large scratches, great care must be taken that no coarse particle get mixed with the fine; and to facilitate the rubbing, oil is also used; but it is to be observed that the oil itself can have no effect in producing scratches, or wearing away; it merely facilitates the motion of the substances used for this purpose.

966. *For taking the rust out of iron or steel*, where it has gone deep, or for wearing away any surface of stone, marble, &c., substances must be first employed, such as sand, sandstone, emery, pounded glass, &c.; and these must be used either with a piece of wood, leather, or cloth, with or without water. For taking out the scratches left by these, and producing a polish, polishing powders must be used, each one finer than the other, as tripoli, putty (the name for oxyde of tin, not glazier's putty), crocus martis, whiting, cuttle-fish bone, &c.; and for giving the highest polish, some of these substances washed extremely fine, and used with oil on leather, felt, or some similar material.

967. *When the surface of any hard substance is to be rubbed off, common sand is, perhaps, the substance most frequently employed.* It consists of minute fragments or broken pieces of the mineral called quartz, and, to be understood, should be examined by a magnifying glass. The grains of which it consists are harder than glass, which it, of course, can grind down. Coarse sand consists of large grains; fine sand of smaller. Sand is never so fine as not to make scratches visible to the naked eye, and therefore it must carefully be excluded from finer polishing powders. It is only to be used where much of the surface is to be removed, or where the articles are of such a nature that a scratch on the surface is immaterial. *Sand-paper*, so well known for scouring, is made by sifting clean sand on paper previously covered with an adhesive substance.

968. *Bath brick.* This is a soft kind of brick, the powder of which is much employed in scouring bright many articles of furniture, as brass candlesticks, knives and forks, &c. The particles of this are not nearly so hard as those of sand. The latter from hardness are seldom bruised much finer in the process of scouring; but those of the brick are broken readily into smaller pieces during the operation, and do not leave those scratches that appear after the use of sand; at the same time that they have sufficient sharpness to remove a portion of the surface.

969. *Common brickdust* is a soft red brick of a similar nature reduced to powder.

970. *Emery* is a substance which is the most powerful in grinding down surfaces, from the extreme hardness of its particles, which are harder than sand; but it is too expensive for common use, and is only employed on particular occasions, where it is required to rub rust out of metals, or remove defects by grinding down a considerable portion. Emery is, in fact, a variety of corundum, the hardest known substance except diamond. It is brought to us in lumps from the isle of Naxos, in the Archipelago, and it is bruised to powder in a powerful stamping mill, and is then sifted into various degrees of fineness. It is used with oil or with water, according to the particular case.

971. *Emery paper* is made of various degrees of fineness, in the same way as sand-paper, and is more convenient than the powder of emery.

972. *Emery cloth is much superior to emery paper* for the purpose of cleaning furniture and utensils of iron and steel. There is a great consumption of sand-paper and of emery paper in private families; but paper is so brittle that it will not hold together after having been used a little while, and, unfortunately, this happens just when its quality as a polisher is the best, from the coarser grains of sand or emery having been rubbed off. By substituting the cheapest kind of calico for paper, an article has been produced, the durability and utility of which more than compensates for the additional cost. It is easily prepared. The calico is strained on stretching frames, after having been wetted with warm size made by dissolving 2 lbs. of glue in 6 quarts of warm water, and then mixing in 2 quarts of water that has been boiled with half an ounce of alum, and 6 ounces of flour. When this size is dry, another coat of stronger size is to be laid on, composed of 4 lbs. of glue dissolved in 3 quarts of warm water, one pint of the first size, together with one ounce of gum arabic, and another of gum tragacanth. While this strong size is yet wet, the emery, sand, or glass powder, is to be sifted on as nearly as possible, and the calico again set to dry, and afterward brushed to remove the loose particles. A second coating of strong size is then laid on, and this is to be covered with another sifting of emery, &c. When dried and brushed, it will then be fit for use. (*Trans. Soc. Arts.*)

973. *Glass-paper* consists of paper covered with powdered glass; it is sharper than sand-paper.

974. *Tripoli* is a pulverulent substance, brought from the Continent, and is much used as a polishing powder. It is of a silicious nature, and hence its power of rubbing down rapidly most substances, while its extreme fineness does not cause visible scratches.

975. *Rotten stone* is a variety of tripoli almost peculiar to England, and found in Derbyshire and North Wales. It is extremely valuable for giving the last polish to metals, glass, and even hard stones.

976. *Chalk* is a pure carbonate of lime, which exists in vast strata in England; when burned in a kiln it makes lime, from the carbonic acid being driven off by the heat. Chalk, before it is burned, is not at all caustic like lime, and is extremely useful, not only for marking, but for scouring and cleaning various articles, and for many purposes in the arts.

977. *Whiting* is chalk entirely freed from the small quantity of sand which is sometimes in it, consequently it does not scratch anything cleaned with it, as chalk may perhaps do. In every other respect it is the same thing as chalk. The French *Meudon white* is the same; but the substance called *French chalk* is very different; it is a greenish gray stone, translucent, and of an unctuous feel, used to mark woollen cloth, and to take out grease; it is not calcareous, but is a compact kind of talc, consisting of silica and magnesia.

978. *Putty of tin* is a powder which consists of the oxyde of tin, much used in polishing glass and other hard substances, and quite different from glazier's putty.

979. *Dutch rushes*, commonly used for polishing wood and ivory, are the stems of plants, called by botanists *Equisetum hyemale*. This plant owes its polishing property to a circumstance that would not be suspected, to the edges observed in its sides being covered with a series of little points of flint set on like the teeth of a saw. This may be made evident by burning a piece carefully, and holding up to the light what remains unconsumed: the little silicious points will be found to be arranged spirally and symmetrically.

980. *Wheaten and oaten straw* reduced to ashes are also found, by the experience of our good housewives, to be good polishers of their brass, milk, and other vessels, without the cause being at all suspected by them. It is a curious fact, that this is owing to an actual coating of flint that covers the outside of the straw, like a varnish, and which gives its lustre; and this flint coating is not destroyed, but remains after the combustion.

981. *The process of scouring* pans will be described under the article "Cleaning the Apartments." Soap will be treated of under the "Laundry."

982. *Fuller's earth*, a substance useful in removing greasy spots, was formerly considered as indispensable in the process of fulling or thickening of cloth, usually termed *milling*, and for scouring them and worsteds, and on that account the exportation of it was forbidden; but lately they have contrived means of effecting the same purposes by soap and other substances, and fuller's earth is less used. It is, however, a material employed in domestic economy, for removing spots of oil from boarded floors, and cleansing greasy vessels of various kinds, &c. Although usually spoken of as being of a saponaceous quality, it has none of the ingredients of soap in its composition, consisting almost entirely of alumina, or fine clay, and silicious earth; the latter in the largest proportion. Every clay that has some unctuosity, that is, which will receive a polish when the nail is rubbed on it, will, in some degree, answer for fulling; but not so well as proper fuller's earth, which is distinguished from common clay by its falling to pieces in water, with a slight crackling noise, instead of making a paste with it, as clay does. When good, it is of a dull greenish-gray colour, and the best is dug in Buckinghamshire and Surrey. The detersive, or absorbing, power of fuller's earth consisting chiefly in the alumina, this ingredient ought to form one fifth of the whole; but not more than one fourth, lest it should be too tenacious.

983. *Sponge* is a marine production, now classed as belonging to the animal kingdom, although this was for a long time doubted. It is composed of minute, elastic fibres, interlaced together, somewhat like a felt. From its property of readily imbibing water, and parting with it as readily when squeezed, it is particularly useful, and is well known as an instrument for cleaning. It is brought from the Mediterranean and other seas, in which it grows at the bottom, and is dived for. When it first comes over, it has often a great deal of sand in it, which must be carefully cleaned out. The best is extremely soft and fine to the touch, and sells for considerably more than the common kind. If carefully used, sponges are very durable.

984. *Black-lead* is a well-known substance, much employed for giving a black, shining surface to cast-iron grates, fenders, and other articles of furniture of this kind. Notwithstanding its name, it has no connexion with the metal *lead*, nor is there any lead in its composition. It is, indeed, a mineral substance dug out of the earth in many countries, in lumps, which are reduced to powder when sold for the use of the chambermaid. It consists essentially of carbon with a little iron, and the finest varieties are employed for making the black-lead pencils for drawing; the best of the latter kind is dug at Borrowdale, in Cumberland; but the common black-lead is found in many other places; a good deal comes from Germany and Spain. There are several qualities of it; the best

is the cheapest in the end; some is much adulterated. The goodness is known by observing the brightness of the polish it will give with the least trouble; for, though many things may increase the apparent quantity, there is no known addition but what must impair this quality.

985. *Sulphur, called also brimstone*, is an extremely inflammable substance, dug out of the earth in various countries, and considered as a volcanic production; or it is procured from mineral substances, of which it is a constituent. The most usual employment of it in domestic economy is for matches, which are made by dipping slips of wood in melted sulphur. The suffocating property of a brimstone match is well known; but the explanation of it is not so, generally. When heat is applied to sulphur, it inflames, and combines with the oxygen of the atmosphere, forming an acid gas, called *sulphureous acid gas*; this is the fume which rises from a brimstone match, and which has a sharp, suffocating smell. When this gas or vapour comes in contact with water, the latter absorbs it to a considerable extent, and when the water is saturated with it, it makes *sulphuric acid*, or oil of vitriol, a strong acid which has more oxygen than the sulphureous acid. The common roll sulphur does not differ essentially (being only less pure) from flowers of sulphur, used as a medicine. Sulphur is one of the simple bodies, or elements, and is therefore incapable of alteration, although it may combine with other bodies, and thus form new compounds. It is common for those unacquainted with a little chemistry, to call by the name of sulphur, and sulphureous, a multitude of things which have no connexion with it; as, for instance, the fumes of burning charcoal; and this leads to absurd reasoning, and to the wrong application of terms. Among the familiar uses of sulphur, we may mention the property which its fumes have of bleaching straw bonnets; and it is likewise employed by the cooper. (See "Wine.")

CHAPTER IV.

GILDING.

986. Some knowledge of the nature of this kind of ornamental work, and the processes employed in producing it, is necessary, with a view to preserve it in a proper manner, and to prevent its being damaged by wrong treatment.

987. *Gilding, in general, may be described* as the art of covering certain substances with gold, either in very thin leaves, in powder, or in amalgam by quicksilver, according to the material to which it is applied, and to the object in view. Wood, leather, paper, and similar substances, are gilded by fastening on leaves of gold by means of some cement; but metals are gilded chiefly by a chemical process, called amalgamation; or, as has lately been discovered, by the action of galvanism. Gilding on wood is the most general, being used for various mouldings and ornaments in apartments, and on articles of furniture, as chairs, picture frames, &c.

988. *Gold has not only the advantage of a rich colour and splendid lustre, but also that of unalterability in the air,* retaining its metallic appearance and beauty in all weathers, and for an indefinite length of time, which is owing to its property of not rusting, or oxydating, by the ordinary causes. Its great value and ductility led the ancients, as well as the moderns, to extend it into very thin leaves, for the purpose of applying it to the surfaces of other bodies, so as to imitate the solid metal; and it is astonishing to what a degree of thinness gold is extended by the gold-beater.

989. *The gold for this purpose must be very pure, and it is hammered out, or beat,* after it has been rolled as thin as paper, by being put between the leaves of a book of parchment and extremely thin skins, called gold-beaters' skin; the book is then laid upon a block of marble, and beat with a heavy hammer. When the leaves of gold are extended to the full size of the book, they are divided, and each portion is placed between the leaves of another book, which is hammered as before. This process is continued till the requisite thinness is acquired. The thinness of gold leaf is quite surprising; it has been calculated that it does not exceed the $\frac{1}{282000}$ part of an inch.

990. *The sort of gilding on wood, called oil gold,* cannot be burnished, and is always of the natural colour of unwrought gold. It has the advantage that it may be washed and cleaned with water, which burnished gold never can. It is often used for picture frames, parts of furniture, and mouldings of apartments; as it stands the weather, it is also employed for out-door work. To gild in oil, the wood, after being properly smoothed, is covered with a coat of what is termed *gold size*, made of drying linseed oil, mixed with yellow ochre. When this has become so dry as to adhere to the fingers without soiling them, or is *tacky*, as the gilder expresses it, the gold leaf is laid on with great care and dexterity, and pressed down with some cotton wool. Any places that have been missed are covered with small pieces of gold leaf, and when the whole is quite dry, the ragged bits are rubbed off with the cotton. This is by far the easiest mode of gilding; any other metallic leaves may be applied in a similar manner. *Pale leaf gold* has a greenish-yellow colour, and is an alloy of gold with silver. *Dutch gold*, which is brought from

Holland, is, in fact, only copper leaf coloured yellow by the fumes of zinc. It is much cheaper than true gold leaf, and is very useful where large quantities of gilding are wanted in places where it can be defended from the weather, by being covered with varnish; but it changes colour if exposed to moisture. It is only a cheap substitute for true gilding, useful where durability is not required, and is that which is used so profusely at present in our paper hangings. *Silver leaf* is prepared in the same manner as that of gold, but it is liable to tarnish, except it be well secured by varnish. If covered with a transparent yellow varnish, it has much the appearance of gold. *Japanner's gilding* is where ornaments are drawn in gold upon japanned work, and is often seen in folding screens, and cabinets, &c. The ornaments are formed by a camels' hair pencil, with japanners' gold size, made by boiling linseed oil with gum animi, and a little vermilion. When the size is nearly dry, gold powder or gold leaf is applied. It is to be understood, that in all cases where gold has been fixed on by means of linseed oil, it will bear being washed without coming off.

991. *Burnished, or water gilding*, is much more difficult; and as it cannot bear being wetted, is only fit for work to be always kept within doors. For this method of gilding, the wood is first covered with four or five coats of whiting and size; and that the gilding should be perfect, it is necessary that there should be a sufficient body of whiting. When these are dry, they are laid over with a coat of gold size made of Armenian bole, a little wax, and some parchment size. When the size is dry, a portion of the surface is wetted plentifully with clear water and a soft brush, and a leaf of gold is dexterously applied, so as almost to float on the water, when it instantly settles down and adheres to the size. Great care must be taken not to suffer any of the water to come over the gold, or a stain will be produced. When the whole is covered with gold leaf, the effect is what the gilders call *matt*, or the natural colour of gold not burnished. Such parts as are required to be burnished are rubbed over with a burnishing tool of agate. Ornaments executed partly matt, and partly burnished, have a very rich effect, which is seen in most picture frames.

992. *We have stated that burnished gilding cannot be cleaned with water, though oil gold may*; but the matt portion of water gilding is so like oil gold as not to be distinguished by an inexperienced eye; and it may be very desirable to know, in that case, by which of the two processes it has been executed, with a view to cleaning it when soiled by flies or otherwise. This may be ascertained by observing in some crack or crevice whether the gold is laid on a coat of whiting; and if there be no other method, a small scratch with a knife may be made in some unimportant part to ascertain the fact. On account of the impossibility of washing water gilding without injury, it is necessary to take great care to protect it from flies, or other causes of soiling it, particularly in the summer season, by covering it over with some fabric of threads woven like a very fine net, as it is observed that flies instinctively avoid anything in the shape of a net. Frames which have been executed in water gilding are sometimes required to be regilt: this cannot be done without taking off the whole of the whiting, and commencing the process again, which is expensive. When this is done, the frames may be either regilt in the water or in the oil manner; and as the last is much the cheapest, it is sometimes preferred. We have observed that oil gilding cannot be burnished.

CHAPTER V.

BRONZING.

993. *Bronzing is a method of colouring wood or plaster of Paris, so as to imitate bronze.* First, the article is to be painted of a dark colour, such as bronze acquires when it has been very long exposed to the air, or when buried under ground. This colour is produced by grinding a mixture of Prussian blue, verditer, and spruce ochre, in oil. What is called *bronze powder*, sold in the shops, is now to be applied, just before the oil paint is quite dry, to the prominent parts, where the metal is supposed to have acquired some lustre by being rubbed against. The bronze powder may be rubbed on by a ball of cotton wool, or in a similar manner. Bronzing has the advantage of wearing well, keeping clean, and giving effect to other colours.

CHAPTER VI.

JAPANNING AND VARNISHING.

994. *Japanning* is a very hard kind of varnishing that derives its name from being an imitation of what we see on the cabinets originally brought from the island of Japan.

995. *The true japan, as practised in Japan and China, is produced* by a kind of liquor or varnish peculiar to those countries; and it is said that it is of a poisonous nature, and injurious to the persons using it. It is the juice of a tree which has the appearance of

cream when it issues from an incision, but, by undergoing certain processes, and being mixed with charcoal or lampblack, it becomes dry, and of a deep black. It is then polished and varnished with some peculiar oil varnish, after having been sometimes painted and gilded. In whatever manner this japan is produced, it is evidently of very excellent quality, and the Eastern furniture covered with it is valuable on account of its containing genuine specimens of the art of decorative painting in these countries.

Formerly a great deal of this species of lackered or varnished furniture was brought from Canton in China. Although it was somewhat inferior to that of Japan, it was a beautiful manufacture, and, when introduced into Europe, was highly appreciated; but the improvements in our own productions have reduced the quantity in demand. These articles consist of magnificent folding screens, cabinets, and other things in daily use among the Chinese.

996. *Our varnishes called japans*, and which are used for tea-boards, tables, chairs, coach panels, snuff-boxes, and other articles, differ considerably from the Indian, but, when well executed, are very beautiful, and generally much better painted. Japanning is executed upon various substances, as metal, wood, papier-machée, and leather; and the process varies in some degree, according to the substances to be covered. When the substances to be japanned are not perfectly smooth, a ground is first laid of strong size and whiting, in order to obtain a perfectly level surface.

997. *In the japanned tea-boards*, of which such vast quantities are manufactured at Birmingham, as the sheet iron of which they are made is sufficiently level and smooth, no ground is necessary, and as the metal can endure a process by heat which other substances cannot, the mode of japanning is different. From the common black japan grounds in iron or copper, the work is painted over with drying linseed oil, and a little lampblack; and when it is moderately dry, it is put into a stove heated to such a degree as to change the oil black without burning it. The heat should be augmented slowly, and continued for a long time, in order to harden the coat of japan. This kind requires no polishing.

998. *When substances not metallic are to be japanned*, a different process must be followed. Here the japan is composed of shell-lac dissolved in spirits of wine, which, when dry, forms an extremely hard coating. Besides the use of the ground or priming of size and whiting mentioned, another was the saving of the japan; but these grounds are generally more or less liable to crack, and are omitted in the best work. The colours required are mixed with the shell-lac varnish, and sometimes with gum animi, and nut, or poppy oil. After the painting is completed, the whole again receives two or more coats of shell-lac varnish, and is then polished with a rag and oil, dipped in tripoli or rotten stone, finely powdered; a cloth, with oil alone, is used to finish with. In this way the beautiful papier-machée tea-boards are japanned and painted; likewise snuff-boxes, waiters, &c. Heat is always more or less necessary to harden the japan, but except in the case of metals, it must be sparingly used.

999. *Japanning is sometimes made to imitate tortoise-shell.* This colour is produced by boiling together linseed oil and amber till the oil becomes very thick and brown. The more transparent parts of the tortoise-shell are imitated by first laying on, thinly, spots of vermilion, tempered with shell-lac varnish, or with drying oil. When the vermilion is dry, the whole is brushed over with the deep brown varnish.

1000. *A varnish for wood that will resist the action of boiling water* is made in the following manner, and is much used in Russia for varnishing their wooden bowls for holding food: Boil a pound and a half of linseed oil in a copper vessel, suspending in the oil a small linen bag containing five ounces of litharge and three ounces of minium, both pulverized, taking care that the bag does not touch the bottom of the vessel. Continue the ebullition till the oil becomes of a deep brown colour, then take out the bag, and substitute another bag containing a clove of garlic; renew this garlic seven or eight times, and put in the whole quantity at once. Throw into the vessel a pound of yellow amber, after having melted it in the following manner: To a pound of well-pulverized amber add two ounces of linseed oil, and place the whole on a strong fire. When the fusion is complete, pour it boiling hot into the prepared linseed oil, and let the whole continue to boil for two or three minutes. Let it rest, decant the composition, and preserve it, when cold, in well-stopped bottles. To lay this on, the wood must be polished; and first a slight coat of some colour mixed with oil of turpentine must be given: a coat of the varnish is then laid on with a sponge; when this is dry, another coat is given, and so three or four coats, as may be found necessary, taking care that one coat is dry before another is added.

CHAPTER VII.

LACKERING.

1001. *Lackering is a thin varnish given to brass work*, such as handles of locks, door plates, &c., to prevent their tarnishing.

1002. *Brass work may be relackered* in the following manner: the metal should be just warmed, and the following lacker laid over it evenly with a soft brush; or small articles may be dipped in it. Put an ounce of turmeric, two drachms of annotto, and two drachms of saffron, into a pint of alcohol; agitate it occasionally during a week, and then filter it into a clear bottle. Add to this three ounces of clean seed-lac, and shake up the bottle now and then during a fortnight.

1003. *A lacker to give tin, or articles covered with silver leaf, the appearance of brass.* Melt, in separate vessels, two ounces of gum-lac and eight ounces of amber, mix them well together, and add half a pound of drying linseed oil. Digest in a pint vial a little saffron in half a pint of oil of turpentine; strain this liquor, and add to it some gum tragacanth and annotto, finely powdered. Mix this last compound with the former, and shake them well. It is by this varnish that leather is made to appear as if gilded, after it has been covered with silver leaf.

CHAPTER VIII.

HISTORY OF FURNITURE.

1004. *General remarks.*—Before we proceed to describe the various articles used as furniture in modern dwellings, a short history of the subject, considered rather as a matter of taste, with some general observations, will be requisite, in order to prepare the reader for understanding and appreciating the various kinds.

1005. *Our object in giving the following descriptions and woodcuts of the household furniture* used at present is, that young housekeepers may acquire, by their means, such a general knowledge of the subject as will be useful in enabling them to inquire after, and to select, those articles which are indispensable. Not only is the expense of furnishing a house so considerable that regard to economy is deserving of attention, but much of our comfort also depends upon the selection being judiciously made in the first instance. Perhaps almost all the articles we are about to describe may be known, in a general way, to most persons, yet it cannot but be useful to have them enumerated, classed, and brought before us, in one view, that attention may be drawn to them in a precise and methodical manner: a task which has not yet been performed in any work of this kind.

We may likewise observe that all the woodcuts of the articles have been made from drawings of the different objects actually in use and on sale at the present period, and not from designs; consequently, they exhibit the forms now in general use in this country.

1006. *It would be in vain to attempt tracing the history of furniture back to the remotest periods*, as there are no materials for this purpose; but the wants of man being nearly the same at all times, we may easily imagine the general nature and practice of this part of domestic economy in the rudest ages, from what we at present perceive among nations yet uncivilized.

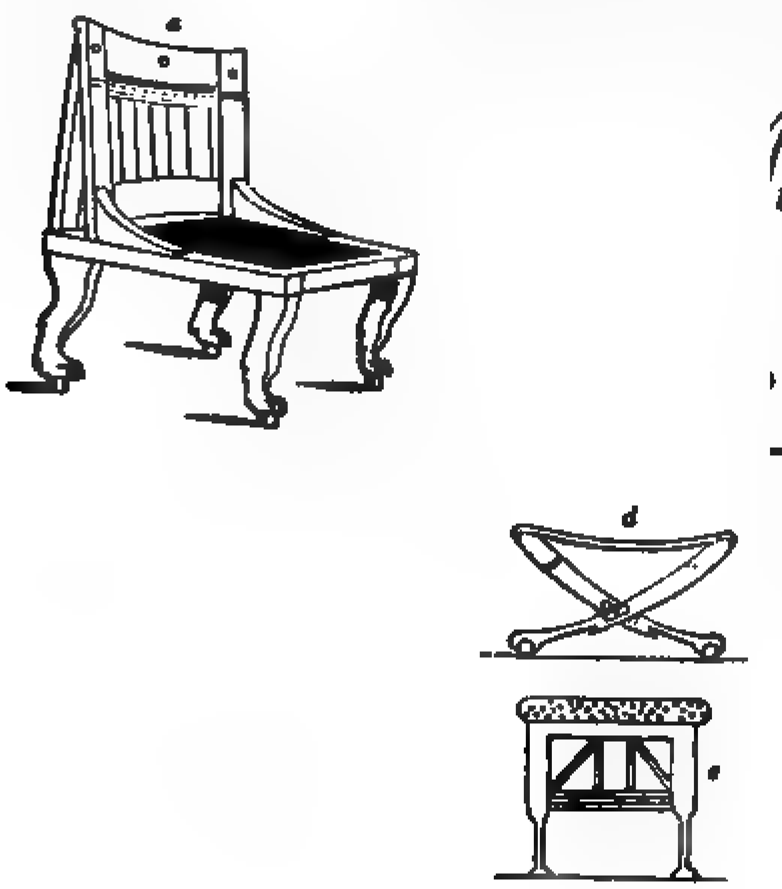


Fig. 180.

1007. *From the discovery of paintings and sculptures in tombs cut in the rocks of Egypt*, and from other researches, we have been lately made acquainted with much of the domestic habits of the ancient Egyptians; and it is as surprising as unexpected to have thus brought before us the forms, at least, of furniture of the time of the Pharaohs. The decorations of ancient furniture frequently consist, in part, of what is now termed the *grotesque style* of ornament, which is composed of a whimsical introduction of carving or painting, representing parts of animals mixed with foliage, and a variety of other objects in which the imagination is permitted to revel without any regard to probability. In the late ex-

cellent work by Sir Gardner Wilkinson, on the Antiquities of Egypt, we see, among many other things copied from paintings on the tombs, representations of Egyptian furniture ornamented in this way; some of the chairs, in particular, scarcely differing from those which come from the modern upholsterer. They appear to have been made of costly wood, carved, and ornamented with inlaying of ivory, ebony, silver, and other precious materials. *a*, *fig.* 160, is an Egyptian chair from Wilkinson, having a curved back, the seat formed of some substance woven, probably split cane, and the legs shaped in imitation of some animal with claws, precisely like those executed at present; it is evident that the cabinet-makers of that time had acquired the art of putting them together so firmly as not to require the assistance of cross-bars. *b* represents an Egyptian lady seated in a chair, nearly of the form of those in a modern drawing-room. *c* is a fauteuil carved in the same style, and having a stuffed seat and back of printed cotton, linen, or leather. *d* is a stool which folded like our camp stools, and which was much used in their houses, often covered with cushions. *e* is another stool of a very usual form.

1008. *There can be no longer any doubt that these fashions were borrowed by the Greeks* who visited Egypt, though they were afterward much improved by the refined taste of that remarkable people. From the Greeks they reached the Romans, and have descended to us after a period of 3000 years. The custom of employing the parts of animals in the ornaments called grotesque is, therefore, clearly of Egyptian origin, if not still more ancient, although the combination of those with foliage and a variety of other objects is the produce of the fine imagination displayed in the Grecian and Roman schools.

1009. *The term grotesque is derived* from the Italian *grotta*, some antique subterranean chambers discovered in Rome having been found to have their walls painted with ornaments in this style. These had not been originally built below the surface of the ground, but had been buried by the gradual accumulation of soil from the ruins of buildings. However at variance with truth and nature are the combinations called "grotesques," they have been found to give delight in all ages, the most exquisite taste having been exercised in selecting and bringing together the most beautiful forms of objects, although in the most capricious manner. Caprice, and even a degree of extravagance, appears, indeed, essential to this style, which aims partly at exciting surprise by the oddity and whimsicality of the inventions. Still, it must be acknowledged that it was practised by the ancients, and occasionally by the moderns, under the regulation of good taste founded upon a perception of the beauty of form.

1010. *What we know of the furniture usually called antique*, that is, of the ancient Greeks and Romans, is derived from their sculpture, and from the classic writers; but most of all, from the numerous articles of this kind dug out from Herculaneum and Pompeii, now preserved chiefly in the museum of Portici, and displayed in various magnificent publications. From these sources we learn that the classical nations bestowed the same care upon their furniture as they did upon all the other objects in which fine art was employed; the same attention to style being shown in everything that has come down to us.

The employment of various beautiful and expensive woods in furniture is not modern. They were much in fashion among the Romans when luxury was at its height. Tables made of them sometimes fetched an enormous price. Cicero is said to have given a sum equal to £8000 for a single table made of cypress; and others are mentioned as equally costly. They were probably ornamented with ivory and carving. Pliny speaks in terms of great commendation of the beauty of the maple wood; and it appears that the art of veneering was known in his time. No actual furniture of this date has been preserved, with the exception of what is made of metal, and which has been found in subterranean excavations.

1011. *The furniture of different periods* has always partaken of the general taste and style of decoration which then prevailed, and it was, in this respect, connected with the architecture of each period: thus the general forms, the mouldings and ornaments, have been derived, in a great measure, from this source. We must expect to find, therefore, that the general decline of the fine arts in Europe, during the later times of the Roman Empire, affected this branch, until, at length, it sank into the general barbarism. Still, in those countries of southern Europe where good taste was once established, traces of it are still noticed by travellers, in the forms of utensils and various domestic articles.

HISTORY OF FURNITURE IN ENGLAND.

1012. From the perishable nature of the materials, and the vicissitudes occasioned by the warlike and unsettled habits of ancient times, nothing remains to us of the furniture of those ages when the nobility and gentry of England resided in castles and embattled mansions. Where security and defence were more objects of consideration than domestic comfort, it is probable that little attention was bestowed upon mere conveniences, and still less upon ornament in household furniture. When decoration was

bestowed upon the furniture of the great, this was in the Gothic style that universally prevailed.

1013. It was not until after the union of the houses of York and Lancaster, when the kingdom was brought into a settled state, that refinement began to be generally manifested in the system of domestic life. Henry VIII., a prince who, with all his faults, had a magnificent spirit and a taste for the arts, employed Holbein, during the intervals of his more important avocations, to make designs for all kinds of furniture, which, in richness, far surpassed anything that had been previously seen in this kingdom. Holbein was born at Basle, in 1498, and was instructed in the arts of design by his father. His talents as a portrait painter are well known; and he was possessed of much invention, as may be seen in his ornamental works, which, however, were in the taste then prevailing on the Continent. He visited London at the request of Erasmus, who recommended him to Sir Thomas More, the portraits of whose family gained him the patronage of Henry VIII.

1014. The best kind of furniture which was used by the wealthy in England during several succeeding reigns was either of Dutch or Flemish workmanship, or in the style of those countries, as may be traced in the paintings of the old masters which represent interiors. In the oldest furniture of this kind, the legs of chairs and tables were straight, but decorated with turned ornaments, and sometimes they were spiral; they had always cross-bars to strengthen them. In the later Flemish more of the scroll-work was introduced; the legs were of rather lighter forms, and somewhat carved; and we perceive the elements of the sort of ornament which was afterward carried to such excess in the reign of Louis XIV. "Flemish chairs of that time," Hunt observes, "were wrought in ebony, walnut, cherry-tree, &c., with high backs, and stuffed in one long upright panel, or filled in with wicker-work; the seats being also stuffed, and covered with costly kinds of materials, as various as their shapes. To those may be added low arm-chairs, tastefully turned, and carved in ebony, enriched with ivory knobs and inlayings, chiefly of Italian or Flemish manufacture, with cushions or pillows on the seats. Besides these, there were some little gilt chairs for women; and long seats, with backs and arms, resembling in form the ancient settle, and holding several persons, were also much in use." "But, in this period," observes the same writer, "the splendour of the coverings of tables amply compensated for the rudeness and simplicity of the work so concealed; the most elaborate embroidery, wrought on the finest grounds, velvets and satins fringed with gold and silver, Turkey carpets, and the choicest tapestry, were devoted to these purposes." To this we may add, that this furniture is, in general, but little adapted for comfort, and has not much of form to recommend it, as far as use and convenience are considered. The backs of chairs almost upright, sloping very little, are inconvenient; they are generally heavy and clumsy; and, though often loaded with carving, this is seldom very tasteful in design, and usually coarse in execution. (See examples of them in Section VIII., Chap. X., "Chairs and Seats.")

In many articles of furniture, as in cabinets, this clumsiness often amounts almost to barbarity, notwithstanding the general rich effect produced by the carver; and the workmanship of the mere cabinet-maker is usually of a very inferior description.

1015. In our observations on architecture, we have already observed that it was in the reign of Henry VIII., and soon after the Reformation, that the ancient Roman architecture began to be introduced into this country, and to supersede the Gothic, which, previously to that time, had been universal in Europe. But, at first, both these styles were mixed together in a very rude manner: this was not peculiar to England, but was borrowed from Italy, where the same practice had long prevailed, and had produced, at last, what has been termed the *cinque cento* style. Notwithstanding the numerous faults and absurdities of this unnatural mixture, and the gross and clumsy designs produced by it, there were frequently, in the details, much taste and knowledge of form in parts—the natural result of the assistance of able sculptors, who were well versed in the study of design, and who had made good use of the various remains of antique sculpture and painting which decorate those edifices that had escaped the ravages of war and time. Thus, in the cinque cento there is often much to admire, although we cannot approve of it as a whole.

1016. We have stated that the style of design in furniture has always kept pace with that of the architecture of the period, the mouldings and ornaments being derived from that art. Thus, when Gothic architecture was prevalent here, the furniture was decorated with ornaments to be found in Gothic buildings; on the revival of Grecian architecture in Europe, the furniture partook of the change; it was then allied to the meretricious and mixed style above mentioned, from which was borrowed the twisted column, and the fanciful but rich carvings of foliage with grotesque animals, copied partly from the antique, partly from modern Italian, and partly from the Gothic. Though there scarcely exists at this time any English furniture of the time of Henry VIII., yet, on the Continent, there is abundance of the age of Francis I. of France, who was his contemporary; and it is frequently remarkable for its quaint carvings in oak, often displaying much taste and boldness of execution.

1017. In the succeeding periods, down to the time of Queen Elizabeth, the fashion of furniture was nearly of the kind above described. Elizabeth was herself fond of gorgeous and magnificent display, with little of good taste. There are but few remains of actual furniture used in England at this time; some genuine examples, however, have been engraved and published by Shaw and other antiquaries. But it is not easy to ascertain accurately the dates of what has been so preserved; and much of it was brought from Holland, Flanders, Germany, and other parts of Europe. What was made in those countries, which produced so many able painters in the Netherlands, was superior to what our artificers could supply at a time when the fine arts were in a very low state in England.

1018. Of ancient English bedsteads of the time of Queen Elizabeth, or the few succeeding reigns, a few remain. (One is represented among our wood-cuts of furniture.) Occasionally some bedsteads in the same style are now imported from the Continent, to supply the fashionable demand for this species of furniture. They are massive, but clumsy, though generally enriched with much carving in oak; in the most superb, the bed-posts are very highly ornamented. The head-board extends to the canopy, and, together with the latter, is covered with carved work; in some there were secret places for concealing money and other treasures. The bed-frame was low, and the curtains and valances usually of thick stuffs; the whole, with the ornaments, causing a great collection of dust, that disagrees extremely with our present ideas of comfort and cleanliness. It would be carrying the love of ancient things too far to bring such again into general use: and examples of them are valuable chiefly as elucidating the history of ancient manners.

1019. If we are to understand by the term "Elizabethan style," so much used at present, the style of architecture and furniture executed in this country during the reign of Queen Elizabeth, we perceive, from what remains to us of that period, that it consisted chiefly of the rude and incongruous mixture we have mentioned; and this is not, as we have shown, peculiar to England, but is to be seen, somewhat modified, in works of the same date, in Italy, France, Germany, and the Low Countries. The practice of Gothic architecture, as well as the revival of the antique, preserved a taste for ornamental sculpture, which was more or less diffused among our artificers; and we find in the domestic edifices of that time, even of the inferior kind, as, for example, in the gables, doors, and windows of the timbered houses, ornaments carved in wood, in which are evident traces of the Gothic; in mansions of importance, as in manor-houses, there are attempts to imitate the then newly-introduced Roman architecture borrowed from Italian architects, by whom it had been corrupted and debased. Yet, notwithstanding the general bad taste of the style, parts had evidently been designed originally by men of talent; and a certain spirit and beauty of line is infused in the ornamental parts, which can never be expected except from those who learn to draw and compose; thus we see a strange mixture and contrast between the powers of the artist and the absurdity of the prevailing taste and fashion.

1020. The desire of discovering something *national* to which great merit can be attached, we have reason to think, has induced many of our architects and amateurs of the present day to assign qualities to the architectural productions of Queen Elizabeth's time, not discoverable by those untinctured with this feeling; and admitting, as we do, that the vestiges of good art are often discoverable in them, the style is, after all, more interesting on account of its historical associations than deserving of imitation or adoption as national; and we should no more wish to see Elizabethan architecture or furniture perpetuated than Elizabethan costume in dress.

1021. We have observed that some difference of design is observable in the old furniture of different countries of Europe corresponding to that of their architecture. Thus the articles originally brought from China and Japan are remarkable for their peculiar paintings, varnishes, and gilding. The ancient furniture of Italy will be found, by those who pay much attention to this subject, to vary from that of Flanders and Germany. The Italian cabinets, particularly those of Florence, are often distinguished by their being ornamented with what is termed *Pietra dura*, which consists of the figures of fruit, flowers, butterflies, and similar objects, formed of coloured marbles inlaid, of which there is a manufactory at Florence, belonging to the Grand-duke of Tuscany. The Spanish and Portuguese are somewhat different from both; but this difference cannot be readily perceived without an accurate critical examination. Those who wish to study it may have an opportunity of seeing specimens, imported from each of those countries, in the show-rooms of Mr. Pratt of Bond-street, so well known by his attention to ancient armour, as well as in other collections made by dealers in London, who devote their time to this branch.

Cabinets were among the most curious and ornamental articles of ancient furniture; and upon them was frequently expended all that the art of carving and inlaying was then capable of effecting. They were used as depositories for plate, china, coins, medals, curiosities of various kinds, and other precious articles for show or use. The interior was fitted up with various drawers and cells, and sometimes contained concealed

places for money or jewels, while the exterior displayed ornamental hinges, escutcheons, panels, with angle and other ornaments.

1022. *During the luxurious reign of Louis XIV.*, when so much encouragement was given to the fine arts in France, they could scarcely be said to exist in England; and out of the cinque cento or arabesque ornament of the time of Francis I. was gradually produced a peculiar species possessed of considerable originality, though extravagant, and which has ever since maintained its ground under the term "style of Louis Quatorze." Although this, like other modern styles, had borrowed something from the antique, it is remarkably distinguished from it; and it affected, in particular, the almost constant employment of graceful curved lines, with great luxuriance of foliage in fine bold relief.

1023. Although the old French furniture cannot be held up as exhibiting examples of refined taste, yet it was gay and lively, and well calculated for the purposes of the ostentatious display of wealth; and having been designed and executed by persons conversant with the fine arts, though of the French school, much of it is at least pleasing in form; while the quantity of gilding, and of all kinds of painting and showy materials, place it in strong contrast with the sombre works in oak and other woods of the preceding times, which, however, are by no means destitute of merit

1024. *The history of furniture in France corresponds with that of the fine arts in that country:* and under Louis XV. some little change is traceable: the foliage ornament became more delicate and of greater intricacy; and during the reign of Louis XVI., the attention which began to be paid to the study of the antique wrought an alteration very sensible upon all designs in the decorative arts. The cabinets of the time of Louis XVI. have a character which enables critical collectors easily to distinguish them. But the great political revolution produced an entire change in the whole of this department. Old forms, as well as old customs and manners, were rejected, and the severely classical became for a time the order of the day, in furniture as in costume. The result was extraordinary. All that species of taste which had been so much cultivated in the preceding times, and which had become peculiarly, and almost exclusively, French, was banished, and the purely antique, or Greek and Roman, was substituted. The French artists likewise carried this to a high degree of perfection, and the designs of Percier and Fontaine, with others of the same school, must be still looked up to as possessed of excellence perhaps not equalled elsewhere. The refined taste of these artists was somewhat perverted, or, rather, wrongly directed, by their patron Bonaparte, whose love of ostentation preferred the gorgeousness of the Roman emperors to the simplicity of the Greek. Of late, the styles of Francis I. and Louis XIV. have been again revived in France; and old French furniture of all kinds, which some years ago was almost thrown away, and might have been purchased for a trifle, is now eagerly sought after and preserved; and its being copied and imitated gives employment to the skilful artisans of the present day.

1025. *But to return to the history of furniture in this country.* Little is known of English furniture during the troublesome times that succeeded the reign of Queen Elizabeth. Notwithstanding the number of old mansions that exist in England, only a small part of the furniture of the same date as the buildings exists, owing to the destruction occasioned by the civil wars, the frequent change of proprietors, with the alterations produced by fashion.

The introduction of mahogany as a material produced a considerable change in this part of domestic economy. The beauty of its colour and grain was such, that it did not appear to require so much enrichment by carving; and the bright polish which it admitted of caused it to be preferred to every other wood: hence we find our notable housewives, from 1760 to 1800, priding themselves upon the lustre of the mahogany produced by frequent rubbing. The use of cloth made of horse-hair for mahogany chairs then became general. Tables were made exceedingly plain, and the carver was scarcely employed, his occupation being afterward nearly destroyed by the invention of composition and plaster ornaments for buildings. Some of the latest furniture, peculiarly English, where carving was in use, may be seen in the designs published by Chippindale, which are partly in the French style: after that, the cabinet work of this country, as far as regards taste, fell into the lowest stage of insipidity.

1026. *With the view of endeavouring to reform this wretched condition into which this branch of art had sunk among us*, Mr. Thomas Hope employed a part of his princely fortune in filling his house in London with furniture of a very superior kind, all of which was designed and executed in this country. To supply some models for improving the taste of the cabinet-makers and upholsterers, as well as that of the public, he afterward caused the whole to be very accurately drawn and engraved, and they were published in a folio volume in 1807. In this work he describes the lamentable condition in which he found this branch of the useful and fine arts; and we cannot do better than quote from the "Introduction" to this work some observations illustrative of Mr. Hope's views: "Each of the different articles of household furniture, however simple be its texture, and however mean its destination, is capable of uniting to the more essential requisites

of utility and comfort, for which it is most immediately framed, and with which it can, consequently, on no account dispense, a certain number of secondary attributes of elegance and beauty, which, without impeding the chief purpose of the object, may enable its shape and accessories to afford additional gratification both to the eye and to the imagination."

"Almost every one of these various articles, however, abandoned till very lately, in this country, to the taste of the sole upholder, entirely ignorant of the most familiar principles of visible beauty, wholly uninstructed in the simplest rudiments of drawing, or, at most, only fraught with a few wretched ideas and trivial conceits, borrowed from the worst models of the French school of the middle of the last century, was left totally destitute of those attributes of true elegance and beauty, which, though secondary, are yet of such importance to the extension of our rational pleasures. Furniture of every description, wrought by the most mechanical processes only, either remained absolutely void of all ornament whatever, or, if made to exhibit any attempt at embellishment, offered in its decoration no approach towards that breadth and repose of surface, that distinctness and contrast of outline, that opposition of plain and of enriched parts, that harmony and significance of accessories, and that apt accord between the peculiar meaning of each imitative or significant detail, and the peculiar destination of the main object to which these accessories belonged, which are calculated to afford to the eye and mind the most lively, most permanent, and most unfading enjoyment. The article only became, in consequence of its injudicious appendages, more expensive, without becoming more beautiful; and such remained the insipidity of the outline, and the unmeaningness of the embellishments, even in the most costly pieces, that generally, even long before the extreme insolidity and flimsiness of their texture could induce material injury in them from the effects of regular wear and tear, the inanity and sameness of their shapes and appendages already completely tired the eye and mind, and left these no other means to escape from the weariness and the disgust which they occasioned than an instant change for other objects of a more recent date and a more novel construction. Thus all those sums and all that labour were wasted upon ever-varying objects of transient whim and puerile fashion, which, by being employed in the formation and in the purchase of objects of lasting perfection and beauty, might have increased in endless progress the opulence of the individual and the wealth of the community."

"If any one felt a desire to decorate his habitation with furniture of superior elegance of form and of design, unable, from the infrequency of the demand, and from the consequent inability of the artificer, to get any such wrought at home, he was obliged to procure it from abroad. Often, at a great expense, he would only obtain the refuse of foreign manufactures; and even where he succeeded in importing the choicest productions of continental industry, these only served to discourage our own artists, to diminish the balance of trade in our favour, and, by a tacit acknowledgment of our inferiority in the arts of elegance and taste, to raise the pride of foreigners at our expense." Mr. Hope adds, that, by adopting in his own case a style of furniture that should employ the talents of the "professor of the more liberal arts, the draughtsman, the modeller, the painter, and the sculptor," he wished, by a successful example, to entice the wealthy to appreciate the charms of art, and divert a large portion of their opulence from being wasted in objects of mere trivial amusement, instead of being expended in those of durable and solid gratification; and, by a patriotic encouragement and improvement of our artists and manufacturers, enable the lover of elegant refinement to procure at home those objects of superior design and execution which heretofore he was obliged to obtain from abroad. Mr. Hope possessed some knowledge of drawing, and he made the designs for the furniture which he procured to be executed, and which are engraved and published in the work above mentioned. The style which he adopted is nearly that which was in fashion in France at the time, and in the invention of which Percier and Fontaine, and other French architects and designers, had so much share. It was founded chiefly upon classical forms, such as are to be met with in antique remains, adapted as nearly as possible to modern wants and usages; and such was the difficulty which he met with in following out his idea, and such was the state of this branch of the art in England at that time, that he observes, "Throughout this vast metropolis, teeming as it does with artificers and tradesmen of every description, I have, after the most laborious research, only been able to find two men to whose industry and talent I could in some measure confide the execution of the more complicate and more enriched portion of my designs; the first a bronzist, and a native of France; the other a carver, born in the Low Countries. I need not add how slow and tedious this scarcity of workmen has rendered the completion of my little collection." It was at length, however, completed; and the novelty and beauty of the style soon had much of the beneficial effect which Mr. Hope anticipated. By the opportunity which he afforded of viewing this superb collection, the taste of the public was somewhat improved, and the manufacturer was stimulated to procure the means of imitating, in some degree at least, the example set before him. It must be remarked, however, that Mr. Hope's taste and knowledge of design in furniture, though superior to what previously existed here, were far from being perfect; and,

with much that was excellent, the style, if strictly adhered to, was scarcely adapted for general use. It was too much limited to the classical style which he aimed at; and, even in that view, it contained somewhat of repetition, as must almost always be expected when the whole proceeds from a single mind; but it is only justice to Mr. Hope to state, that he was aware of this difficulty and objection, and offers his labours to the student in the arts, not as models for mere servile copying, but to show how, by applying to the same sources from which he drew his ideas, a new line of art might be opened, capable of endless improvement. It must be admitted that an immense debt of gratitude is due to the memory of Mr. Hope for this noble example of the mode in which a man of fortune may benefit and improve society, by refining taste and furnishing employment to the industrious. It had at once the effect of producing a complete revolution in our furniture, which from that time has been improved in a very great degree.

CHAPTER IX.

PRESENT STYLE OF FURNITURE.

With respect to the style of furniture in fashion at the present time in this country, it is difficult to say what it is, and, indeed, it does not admit of any accurate description. The classical style of Percier and Fontaine, and we may add that of Mr. Hope, the Flemish or Elizabethan, that of the time of Francis I., that of Louis Quatorze (see examples of chairs in each of these styles, in Sect. VIII., Chapter X.), the Gothic, and even the Chinese, have all lent their aid to supply ideas; and this branch has been so much improved since Mr. Hope commenced his reform, that, instead of the extreme paucity of talent of which he complained, we now possess a few able designers and carvers who are chiefly in the employment of our first upholsterers. At the present moment, however, the strictly classical style is not in vogue, probably, in a great measure, from the same kind of difficulties experienced by Mr. Hope, and its consequent expense. It is a character of the present period to possess, in particular, the revival of two styles which had been for many years laid aside; namely, that of Louis Quatorze, and that now called Elizabethan, each of which will demand a few farther observations.

1027. *The style of Louis Quatorze is known*, as we have stated, by its abundance of light ornamental scroll-work and foliage. Its elegance of form, though not of the first order, together with its admission of every species of enrichment, as carving, gilding, painting, inlaying, with coverings of the richest silks, velvets, and the choicest stuffs, admirably adapt it for the modern drawing-room. Certainly no kind of furniture equals it in the general splendour of appearance; and, at the same time, all the decorative part is of such a quality that it can be executed by artisans of the second and third grades; the figure, which demands the first, being very seldom introduced. Hence its cost is much less, in proportion to its show, than where artists of greater skill are required.

1028. *On the style usually called Elizabethan*, including that of Francis I., and the Flemish, we have already made some remarks in our "History of Furniture." Notwithstanding the influence of fashion, and taste for novelty, which are apt to warp our judgment, it is impossible seriously to admire this style in genuine examples; and we have already alluded to its general coarseness and clumsiness of form, and want of adaptation to its use, although occasionally it is rich in effect, and interesting through a certain association of ideas. It is curious to observe the steps by which certain styles, obsolete for so many years, have been revived and brought again into fashion. At first this was a subject merely of antiquarian research, which was made interesting, not merely by collecting ancient articles, but by repairing and restoring some of them to their pristine appearance. Some apartments in ancient mansions remaining entire, these were afterward supplied by ancient furniture, together with restorations and imitations of these. Next, zealous individuals went so far as to build houses in the style of the olden time, the apartments of which demanded that the furniture should correspond. These appeared as novelties; and the contrast between the rich furniture of the ancient period, and the plainness of the existing style, recommended them. By degrees this got into fashion, which is everything to the many.

We must, however, in justice to our readers, remark, that all this has arisen from the incessant desire for variety, which the existing skill of our artist is yet unable to satisfy; and hence recourse must frequently be had to copying, rather than to inventing, and to reviving old and obsolete forms, which, though bad, have a kind of novelty merely because they had been forgotten. We cannot conceive, however, that this species of taste can last; it will some day have its crisis, when art shall have improved among us; and we cannot, therefore, recommend laying out large sums in the execution of what will, we apprehend, ultimately be considered as demonstrative of an obliquity of taste. But we are aware how nearly useless it is to decry a fashion at its height.

1029. *It may be proper to state*, because it is not generally understood, in what way our shops are filled with *ancient* furniture, to satisfy the present demand; and there are many, no doubt, who imagine that in purchasing these they are obtaining genuine ex-

amples of what were used by our ancestors. The fact is, as we have already observed, that very little really English old furniture remains; and what does exist, is now carefully preserved, and scarcely ever comes into the market. The old furniture seen so abundantly at the upholsterers and brokers, as also at auctions, is imported from the Continent. Persons are sent over to travel, and to penetrate even into obscure places in Holland, Flanders, Germany, and other parts of Europe, in search of these treasures, where they still exist in their original state; and these are brought over almost in shiploads. What is portable is frequently carried and sold as it is; but a great deal is taken to pieces, and only the carved and ornamental parts conveyed. These are purchased at sales by our cabinet-makers, who dissect them, and make up the parts into articles adapted to our wants and customs, skilfully inserting the old carvings, so as to make the whole resemble an original piece of furniture. In these recompositions, considerable skill, and often taste, are employed; the most uncouth pieces are rejected, or placed so as to strike chiefly by their oddity, or by giving an antiquated air. Cabinets have new drawers, sometimes of old wood; all defects are repaired, pieces made to match others that are wanting, or too much worm-eaten; or they are metamorphosed into wardrobes. Chairs are mended, varnished, and re-covered with rich velvets or silks. Sideboards, and other useful and modern articles, are composed out of various fragments; and among these restorations we can sometimes detect even the ornaments of churches which have suffered during the suppression of convents, and other changes consequent upon political revolutions. By this ingenious means, a species of magnificence is produced, comparatively at a cheap rate; for such articles do not, after all, cost nearly so much as a similar piece of furniture would do if made and decorated with as much carving; to say nothing of the impossibility of our mechanics at present equalling the merit of much of the ancient carved work.

Still, we must beg to repeat, that, although such furniture has an interest from its singularity and historical associations, yet the magnificence it is calculated to exhibit is of a gloomy cast, and rather carries us back to unrefined and semi-barbarous times, than keeps pace with, and forwards, real improvement in taste, having no kind of intrinsic superiority. There are in London certain upholsterers who particularly deal in this ancient furniture, the procuring of which forms, indeed, a particular line of business; others prefer making designs of a novel kind, avoiding exact imitations of any old styles. This subject will be exemplified in the wood-cuts of furniture.

CHAPTER X.

FURNITURE OF THE PRINCIPAL APARTMENTS.

1030. A complete list of furniture will be found at the end of this section; and the following pages will contain descriptions of all the principal articles, with remarks calculated to facilitate an acquaintance with their various qualities.

Sect. I.—WINDOW CURTAINS.

1031. Window curtains add much to the comfort and elegance of apartments; considerable taste and judgment are exercised in designing them of the most agreeable forms, and adapting them in the most judicious manner for the several places to which they are destined. Their use is either to add warmth to the apartments by excluding the draughts of cold air; to exclude the rays of the sun, which, in summer, are injurious to furniture; to keep out insects; or to prevent persons seeing into the house; and, according to these several purposes, and the nature of the apartments, the quality of the materials, and the manner of hanging them, must be determined.

1032. *In this country, particularly, window curtains are necessary to exclude the cold air,* which presses in from the windows, especially in winter, when the fires are burning, however close the sashes may be made. But there is another cause for the cold proceeding from windows, which is not generally thought of. The warm air in the room, which always occupies the upper part next the ceiling, coming into contact with the glass, is cooled by it, and, immediately descending in consequence, diffuses itself through the lower part of the room, and is felt as a cold current coming from the windows, although none may have entered that way. Curtains check this by partly preventing the warm air from reaching the glass, and partly by directing the current sideways. Curtains likewise hide the unsightly appearance of the shutters with their fastenings, when closed. In warm climates they are used rather to moderate the sun's rays, or to prevent the intrusion of flies; and this is their principal use with us, independent of their ornamental appearance in the summer season; then, figured muslins are often employed alone.

1033. *Light, which is so favourable to the life and health of living beings, is very prejudicial to furniture, by destroying its colours.* It may be observed that those portions of the furniture of a room, particularly when of dyed materials, on which the sun is permitted to shine, will be much faded, while those parts which have not been so exposed may retain their original brightness.

1034. *The effect of the sun's rays upon oil colours* may be mentioned as an exception to this rule; for pictures painted in oil, which are put away with their faces turned to the wall, change much more than when hung up and exposed to the light; it may also be observed, that those parts of walls which have been long covered by pictures or mirrors have changed and become darker than the rest: oil paint, therefore, does not suffer from the sun's rays. Water-colour drawings, however, suffer much from being always exposed to the light; and, when valuable, should be defended by a silk screen, to cover them when not required to be seen.

1035. *The simplest kind of window curtain*, which may be used in the bedrooms of small houses, or in cottages, consists merely of two pieces of dimity, printed calico, muslin, or other material, of the proper length and width, nailed to the top of the architrave, or to a piece of wood fastened up on purpose, as in *fig*. 161, *a*, and kept back in the day by being looped up on each side, by a cord fixed on the sides of the window. This curtain may, if thought proper, have some kind of border at the top, with or without a fringe, as in *fig*. 161, *b*.

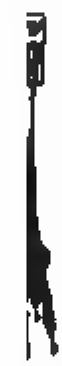


Fig. 161.

Another simple mode is to have the curtain in one piece to draw up by means of lines and pulleys, as in *fig*. 162. To effect this, a pulley is fixed at each end of a flat piece of wood as long as the window is wide; and another pulley is let into the wood, so as to divide the lath into two equal parts. The curtain is nailed to this wood, and pieces of tape are then sewed down the curtains at the two sides, and also just under the middle pulley, and there a number of rings are fixed. Through these rings are passed three cords, which go over the pulleys, and are then fastened together; by means of these cords the curtains can be raised or lowered at pleasure. The boards, with the pulleys, may be concealed by a lath covered with a border, and having a small valance; these are called by upholsterers *festoon* curtains, and were very general before the French manner was introduced of making them slide on a rod.

Fig. 162.

1036. *The general mode of hanging curtains at present*, in the better sort of rooms, is by having rings at the top of the curtains, passing over a rod stretched across, by which each half of the curtain is drawn to one side of the window, as in *fig*. 163, A. This curtain rod may either be visible, or may be concealed by a cornice, valance, or drapery. When it is intended to be visible, it is made thicker, of wood or brass, and is then termed a *pole*: when it is not to be visible, it is made thinner, of iron or brass. The curtain pole is supported at each end by an iron bracket screwed to the architrave of the window, as in *fig*. 163, B.

1037. *The best method of causing the curtains to open* is the following: on each end of the brass curtain rod, *a*, *b*, *fig*. 163, C, are pulleys, one at *a*, and two at the other end, *b*, *c*. A line, *d*, passes over the pulley *b*, then over that at *a*, and after going over the pulley *c*, returns down by *h*, to join *d*, by passing over the wheel in the little brass rack which is placed at *e*, and screwed on the architrave, or otherwise fixed. Each corner of the curtains, where they meet, is attached to rings, *f*, *g*, which slide on the curtain rod. By considering the motion of this line over the pulleys, it must be evident that when it is drawn down by pulling at *h*, the curtain attached below the rod to the ring, *g*, must move towards *c*, and, consequently, open; while, at the same time, the other curtain, fixed above the rod to the ring *f*, must also open by moving in a contrary direction.

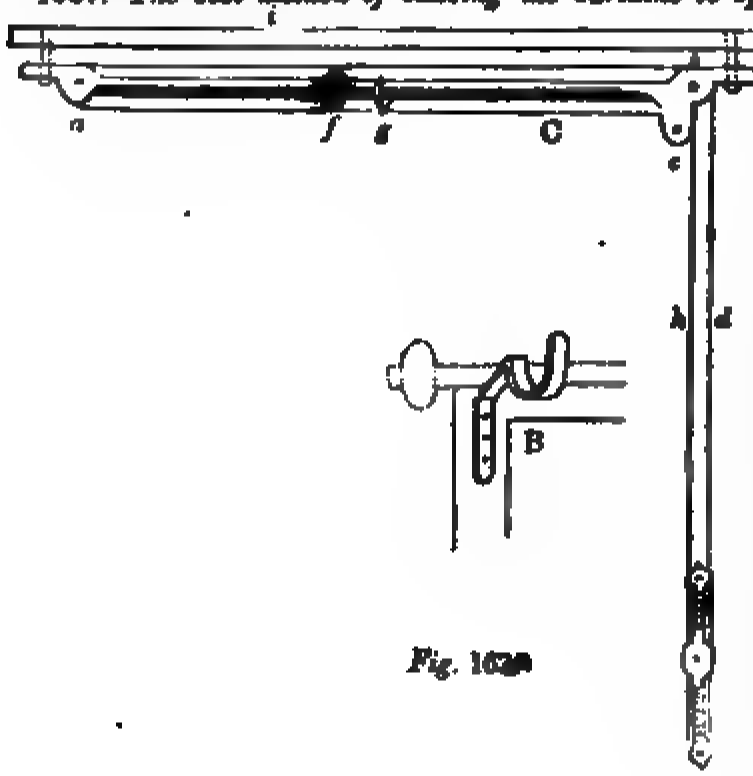


Fig. 163.

Each end of the curtain is fixed to the under side of the projecting lath, *i*, by screws. This curtain rod and pulleys may be made of hard wood instead of brass. It is to be observed, that each curtain must be large enough to lap over the other some inches in the centre, to exclude the draught.

1038. *Besides the rod on which the curtain slides, there is generally a piece of the same material with the curtain, called a valance,* suspended before it, to conceal the rod, and likewise the soffit, or under side, of the architrave. This valance gives great richness and finish to the window; but when the rooms are low, they should not be deep, as they then hide much of the light: on the contrary, when the windows are very lofty, they are often useful in moderating the too great glare of light. Valances are contrived in a vast variety of modes, on which depends, in a great measure, the style of the window. Sometimes they are made in the form of festoons, and are then, by upholsterers, termed *draperies:* the festoon itself is called the *swag*, and the end that hangs down is termed the *tail:* see *fig.* 164. These are frequently ornamented with fringes, tassels, and cords, in various ways. This, which is the former French style, was introduced some years ago, as being much richer and more elegant than ours; at present it is less used, and what are called *piped* valances are more generally put up; these harbour less dust, from the folds being perpendicular. Lately, massive brass rods and large rings have been much in fashion; also, rich gilt cornices over the valances.

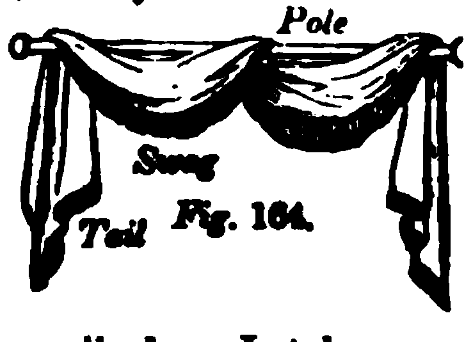


Fig. 164.

1039. *The materials for window curtains* must necessarily vary with the apartments where they are to be used; but, independent of the difference of expense, the choice of their qualities depends upon several considerations. In forming graceful drapery, the material is of great importance. It is impossible to form them well of stiffened materials, such as highly-glazed calicoes, which will not, of themselves, fall into graceful folds, and must consequently have a stiff appearance. Pliability of the material is essential; and, for this purpose, silk and fine cloth are considered the best substances. In drawing-rooms, plain coloured satin, or figured damasks, bear the first rank for richness. Lutestring and tabarets next, though they do not make so good drapery. Salisbury flannel, fine cloth, or cassimer, are sometimes used. For eating-rooms and libraries, a material of more substance is requisite than for drawing-rooms; in these, moreen is most usually employed. When chintses are used, they should not be much glazed.

1040. *One inconvenience in the elegant French draperies* was the great skill and taste required to put them up well; and it is said that the cutting out of this part of upholsterers' work was kept as much as possible a secret, and seldom taught, even to their apprentices. A book, called the "Upholsterer's Accelerator," gives rules for this purpose.

1041. *The manner of looping or fastening up the curtains in the day* is varied, by hanging them over a large ornamented brass pin, by an ornamented brass band, or by silk cords and tassels. It requires some taste to dispose the folds properly, and some housemaids excel others in this part of their duty. The colours of window curtains should harmonize with the rest of the room, as well as with the richness of the materials. When we say harmonize, we do not mean they should correspond, or be the same, but that there should not be any violent contrasts, and that the colours should agree with each other. As the sunshine causes the colours of window curtains to fade, they should, when convenient, be taken down in the summer, and muslin curtains only kept up.

1042. *The designs for window curtains* have been almost infinite; but it must be allowed that our neighbours the French have, until lately, displayed more taste in this department of domestic decoration than our upholsterers. The present fashion for plain or piped valances renders this easier. We proceed to give some examples of the usual style of window curtains.

1043 *Fig.* 165 is an example of a window curtain with cornice and valance, in the style very prevalent in the present day. The cornice is carved and highly gilded, from which descends a deep rich fringe. There is a double set of curtains; one of some of those rich materials mentioned above for the evening, and another of figured muslin for the day.

Fig. 166 is another design for a cornice and a piped valance.

Fig. 167 is a cornice and valance in the style called of Louis XIV., now much in fashion. The cornice is wholly gilded, and the valance may be of rich silk and fringe.

Figs. 168, 169, 170 are various designs for window curtains and valances in the style of the French draperies.

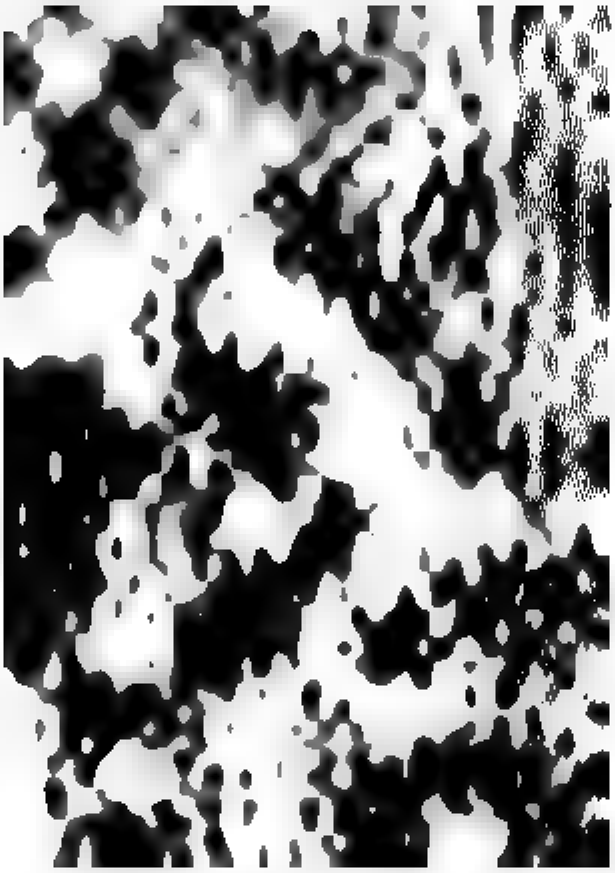


Fig. 169.

Fig. 170.

Fig. 171, is one now a good deal used, with the cornice plain, and the brass curtain rod visible.

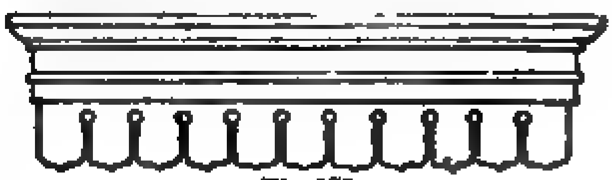


Fig. 172.

Figs. 172, 173, 174 are cornices and valances suitable for bedrooms.

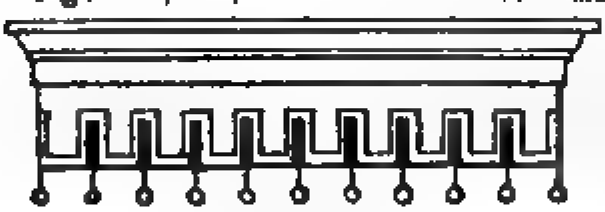


Fig. 173.

Fig. 174.

1044. *Muslin curtains* are almost always used in the best rooms in addition to the usual thick curtains. They serve to shade and protect the colours of the others from the dust and sun, and have a clean and rich appearance. The muslin is richly flowered in large patterns, and many persons in summer take down the principal curtains, leaving only those of muslin: these are useful to keep out the flies when the windows are open. Curtains for this purpose are sometimes made of an open netting, which is very durable.

SECT. II.—WINDOW BLINDS.

1045. *Window sun blinds* are either for excluding the sun's rays, or for preventing any one passing from seeing into apartments; at the same time permitting a view from within. For the first purpose, they are either outside or inside blinds.

1046. *Outside blinds* have been already treated of in p. 60.

1047. *For inside sun blinds*, the Venitian are sometimes used, when it is requisite to exclude the sun very effectually These consist of a number of thin laths lying horizontally, generally painted green, and having two pieces of tape stretching across them from top to bottom, by which they are moved, and open to any degree, so as to let in more or less light. These, when placed inside, do not shut out the rays of the sun so completely as when put outside the sash; and, though they are more accessible, they have the inconvenience of darkening the room too much

1048. The most usual kind for the inside are *Holland* blinds, which are either plain

rolling blinds without springs, or spring rolling blinds. The Holland is a particularly strong linen, woven on purpose, the usual width of windows. The common roller blind is simply nailed on to a wooden roller, the lower end of the blind being kept distended by a lath passing through a broad hem. The roller at the top turns upon pivots at each end. At one end is a wooden or brass pulley, over which a smooth cord passes in a groove, and extends also over the small wheel of a pulley-rack fixed on the head of the sash, and which is so constructed that the cord can be tightened when it becomes slack. By pulling this endless cord the blind is raised, and is pulled down by a short cord and tassel.

1049. *Spring rolling blinds* have a wire spring inside a tin roller, which acts so as to turn it, and the blind is raised up by merely pulling a cord: these are much more expensive than the common roller-blind, which has the advantage of greater simplicity, and being less apt to be out of order.

1050. Sun blinds are likewise made of *linen painted as transparencies*; and some of these are extremely beautiful, representing scenes in nature, either landscapes, interiors of buildings, or arabesques, and are particularly convenient when it is desirable to exclude the view of disagreeable objects. They are put upon rollers in the same manner as other blinds, being painted in varnish that does not crack in rolling.

1051. *Short blinds* to prevent seeing in, generally reaching half up the lower sash, are sometimes made as low curtains, of muslin, with a frill, and stretched on a brass rod across the window; but the better houses have either Venitian blinds of short perpendicular laths, or blinds made of woven wire, or pierced zinc, put into a mahogany frame. Woven wire makes an excellent blind, being desirable, and admitting of being ornamented by painting in oil upon it. They are not apt to be out of order, as is the case with Venitian blinds, without great care.

SECT. III.—CARPETS AND RUGS.

1052. In no country are carpets in such general use for covering the floors as in England. In Asia, where they were first invented, they are seldom used except to sit or sleep upon. Before the use of carpets the floors of the best houses in Europe were laid with oaken boards in the manner called *marqueterie*, and they were generally kept highly polished with wax, which sometimes caused them to be unpleasantly slippery. It is scarcely yet a century since the first appearance of carpets in this kingdom; and at present it is computed that in England and Scotland there are two hundred millions of yards in constant wear.

1053. *The manufacture of carpets was introduced* into France from Persia by Henry IV., and a magnificent royal manufacture exists at present at Aubusson, in the south of France, where carpets of the most superb description are made, in the manner of velvet, and also in that of the tapestry of the Gobelins. They are generally ornamented with designs after the antique arabesque. But these luxurious articles are necessarily confined to the opulent; and a great majority of the people of the middling classes in France scarcely know the use of carpets, which are so general with us, tiled floors being the most common among them. Of late, however, the great influx of English has caused carpets to be introduced into public hotels and lodging houses, from which they are spreading more generally.

Near to Brussels there is a manufactory, where every kind of carpet is well imitated, from Persian to Scotch. In America carpets are universally used as in Britain. The best carpets are composed all of dyed wool: some have parts made also of hemp. They are wrought in fanciful patterns, varying in their style according to the place of manufacture.

1054. *Carpets are of two kinds*: that of double fabrics, consisting essentially of two distinct webs woven at the same time, and firmly decussated together by the woof threads. Hence the form of the pattern is the same on the two sides of the cloth, only the colours are reversed, so that what is green on one side becomes, perhaps, red or black upon the other, and *vice versâ*. The smaller the figures the more frequent the decussations, and the firmer and more durable the fabric. The other kinds have a raised pile on one side like that of velvet.

1055. *Turkey and Persian carpets*. This excellent manufacture originated in Persia, Hindostan, and Turkey, from whence many were formerly imported into Europe, as they are now occasionally, being brought chiefly from Smyrna. They were long unequalled for richness of fabric and pattern, though at present the manufactories on the Continent produce some that are not inferior. These kinds are woven with a soft pile somewhat similar to velvet, and some of the richest of the Persian have floss silk mixed with the wool. The manufacture of Turkey carpet was brought to England in 1750 by two workmen from France, and through the exertions of Mr. Moore, secretary to the Society of Arts, was, after some difficulty, brought to great perfection. These are very frequently used in good dining-rooms, being exceedingly warm and durable, but from their great weight, are difficult to shake. They are made in one piece, sometimes even eight or ten yards long, and five or more wide.

1056. *Brussels carpets* are not made in large squares, but in pieces about seven eighths wide. The basis is composed of a warp and woof of strong linen thread; worsted threads are also interwoven, which are formed into loops by means of wires; and these form the pattern, the linen threads not being visible on the surface. When well made they are very durable, and being at the same time elegant, they are at present much in request for the good apartments, the kinds mentioned previously being much more expensive. They, however, vary much in quality: the best kind ought to weigh 1¾ lb. per yard; but of late they have been manufactured in a slighter manner, and often do not weigh 1¼ lb. per yard. There is also a *Tournay* carpet very similar. The names of our carpets do not always denote either the present or the original place of manufacture. Our Brussels carpets are made chiefly at Kidderminster. What are called Kidderminster carpets are mostly made in Scotland and Yorkshire; and it is not known that what we call Venitian carpeting was ever made in Venice.

1057. *Wilton carpets* differ from the Brussels in this: when the wires upon which the loops are formed are drawn out, the worsted loops are cut through with a sharp knife, and then they form a pile in the manner of plush or velvet. The basis is linen. This manufacture was introduced into this country through the exertions of Lord Pembroke; and they have the advantage of being executed in very beautiful designs. In the *Royal Wilton* the pile is raised higher than in the common Wilton.

1058. *Velvet pile carpets* are a kind lately introduced, resembling the texture of the Wilton, but superior in richness of pile and the colours. They are sold at from ten to fourteen shillings a yard. Nothing can surpass their beauty and rich effect, and they are of English manufacture.

1059. *Axminster carpets*, so named from the town in Devonshire where they are chiefly manufactured, are woven in one entire piece, and are executed in very beautiful designs, several persons being employed at the same time in working the coloured patterns. The manufactury was established in 1755. The warp and shoot are of strong linen, and numerous small tufts of differently-coloured worsted are fixed under the warp and secured by the shoot. The process of weaving them is tedious: hence the carpets are necessarily expensive, and the whole quantity manufactured is not considerable.

1060. *Kidderminster carpets* are composed of two woollen webs, which intersect each other in such a manner as to produce definite figures. In carpets of two plies the warp and woof appear on the same side, and, of course, on the two sides the colours are reversed, as the warp or woof appears. Three-ply carpets have lately been made, in which the woof shows the figure. These carpets are made in squares, to suit rooms of various sizes. There are various qualities according to the price, which varies from 1*s.* 6*d.* to 3*s.* 6*d.* per yard. The cheapest are very loosely woven, having the woof much thinner than the warp; these soon wear out: the best are closely woven, and have the warp and woof of equal strength.

1061. *Common Scotch carpets* are among the cheapest kinds, and are often confounded with the Kidderminster.

The three imperial Scotch carpet, which is coming much into vogue, is reckoned by many to be little inferior, in texture, look, and wear, to the Brussels, though much cheaper. It is made chiefly at Kilmarnock.

1062. *Dutch carpet* is a very strong and cheap carpeting, lately introduced. It is yard wide, about three shillings a yard, all wool, and superior in wear to Kidderminster, but only woven yet in stripes and checkers.

1063. *Venitian carpets* are of the simplest kind, the texture of which is plain: a striped woollen warp on a thick woof of thread made of hemp, cotton, or woollen; and the warp is so thick as to cover entirely the woof.

When the warp is hemp this cuts the woof, and occasions the carpet not to be durable: a cotton warp is better; the best Venetian carpets are all of wool. A superior sort is called damask Venitian, which partakes of the character of Venitian and Kidderminster. Venitian carpeting is used chiefly for bedrooms and stair-carpets, the dust adhering less to them than to others.

1064. *Carpets made entirely of hemp* were at first imported from Russia, but are now made here: they are extremely cheap and durable, but they have this disadvantage, that, when soiled by the feet, they cannot be cleaned completely by the usual brushing given to a woollen carpet: they are, however, useful in passages, offices, or places where a cheap carpet is required merely to deaden sound, and where the appearance is not important. They are sometimes sold as low as 6*d.* a yard, yard wide.

1065. *An excellent covering for the floors of offices and business rooms* is now made of cocoanut fibre. It is woven open, to let the dust pass through, and it is extremely durable and cheap: 2*s.* a yard, yard wide.

1066. A coarse kind of carpet for covering stair-carpets is likewise made of *New Zealand flax.*

1067. *Drugget* is a coarse woollen cloth, sometimes all wool, and sometimes the woof wool and warp flax thread. They are stronger, and have less nap than baize, and, among other uses, are employed occasionally as floor-cloth or cheap carpeting, or to

cover carpets, for which purpose they are woven from a yard and a half to two yards and a half wide.

Milled drugget is a fabric lately introduced: being painted in rich colours, and very thick and strong, it forms a very good substitute for carpets in small apartments. It is made yard wide, yard and half, and even two yards: the price very low.

1068. *In laying down carpets*, the most complete way is to fit them into all the recesses of the room; but this is also the most expensive, since not only all the carpet seen when laid down is charged for by the upholsterer, but likewise all that is cut to waste, which, in some apartments, is a good deal. Where economy is an object, the carpet may be square or oblong, according to the shape of the room, but not fitted into the recesses; and the boards round the sides may be left bare, or be painted in oil, or covered with oilcloth, baize, drugget, &c.; or, lastly, as a still more economical mode, there may be a border only of carpet round the room, and the middle part may be covered with a drugget, painted or not, which will look as if the latter covered the middle of a large carpet; and this has the advantage, particularly for bedrooms, that it is easily taken up to be shaken and dusted. With respect to the economy in not fitting carpets to rooms when square or oblong, they can have the wrong side turned up for a time to save the other side, which cannot be done when the carpets are fitted in; and they may likewise be reversed in their position, which will make them wear more equally. Thus a square carpet may have its position changed eight times, and an oblong one four times; whereas a carpet fitted to the room cannot be altered in its position, except the apartment should be exactly symmetrical, which is seldom the case.

1069. *In the wear of carpets* much depends upon the manner in which they are kept clean: if the dust is suffered to accumulate too long, they require to be beaten with much force, which breaks the threads. In some cases they are scoured; but this is very apt to injure their texture. It is important to the preservation of carpets that the boards of the floor be well laid; if they have not been properly seasoned when they were laid down, they sometimes turn up at the edges, and occasion ridges, which will cut the carpets, and cause them to wear there soonest. As soon as a carpet begins to wear, its position in the room should be altered, that every part may be worn alike. Thick and heavy carpets do not require to be nailed down; but those that are thin usually require nailing in sitting-rooms, otherwise the edges curl up and are inconvenient; but if they are well nailed at first, and stretched, after a month or two they will lie flat with fewer nails, so that they may be easily taken up to be beaten. The air of a sitting apartment is materially injured by the dust being suffered to accumulate under the carpet. Every time it is swept a cloud of dust rises and mixes with the air; and, although this is scarcely visible, it proves injurious to the lungs. Carpets in bedrooms are seldom nailed down, and never ought to be, that they may be frequently beaten and brushed.

1070. *The size of the patterns* should be suited to that of the apartments. Large patterns are only fit for large apartments, and small patterns are more easily mended: those with geometrical figures have this advantage, that pieces may be let in where parts are worn, which is more difficult in irregular patterns. It is also economical to have several of the carpets in the house of the same pattern, as those of bedrooms, passages, &c., that one may mend another.

1071. *The colour of carpets* should be well attended to; and much taste is required to choose patterns and colours that are the most suitable for the apartments where they are to be put down. In this fashion will generally be followed; but it is very necessary to consider also the nature and use of the apartment, and style of the furniture. In the richest carpets, intended for the best apartments, the style is usually gay and splendid: for parlours, the Turkey and Persian patterns, having a richness of effect without any conspicuous or distinct figures, are preferred; and for sitting-rooms and libraries, something of a quiet, though not too dark character, is preferable. Carpets with only two colours are often very elegant; but they easily show any stains on them, and, consequently, do not wear so well as when there is a sprinkling of a few more colours intermixed, the spots of colour assisting to disguise those arising from stains. It should be observed, likewise, that some colours are more liable to fade than others.

Those who would be thrifty should have their carpets mended with the needle in time, when they begin to wear; and this may be done somewhat in the manner of embroidery, making use of proper coloured worsteds to make out the pattern: a precaution, however, which is seldom taken.

1072. *Hearth rugs* are to save the carpet near the fire, where it is most liable to be worn, and likewise to afford greater warmth and softness to the feet at that place. They vary much in style and price, and should be chosen to suit the carpet in colour and degree of richness; but they are too well known to need particular description. Where economy is much an object, a piece of carpet of the same pattern as that of the room may be used, with some border sewed upon it.

1073. *Door Mats*.—These articles, used for wiping the dirt from the shoes, are made of various materials. Those placed in the entrance of the hall are of a coarser and rougher kind; others, of a finer sort, are placed at the foot of staircases, and at the en-

trance of apartments. A very coarse mat, of German origin, called here the *skein* mat, is made of tarred rope, or of cocoanut fibre, *fig.* 176, which is very durable, and calculated for places where much dirt is made: first a rope goes round the outside, to form the boundary of the mat, and the same kind of rope fills up the interior, in zig-zag lines, being fixed with cord in that position, or in any other pattern that may be suggested. As there are interstices between the ropes, the dirt falls down in the cavities, and when these are full the mat is easily cleaned by lifting up and shaking. It is obvious that persons in the country, who wish to be economical, could easily construct mats upon this principle, either of old rope, plaited straw, or any similar material.

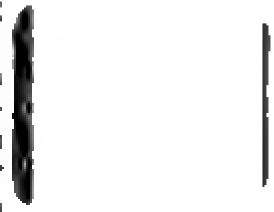


Fig. 176.

1074. The most serviceable coarse door mats are made of cocoanut fibre; a finer kind is made of the same, with worsted-coloured borders, woven so as to have a brush-like appearance. A very cheap kind is likewise made of straw, or of a kind of tough grass. Fine mats to put before the doors of apartments are made of Indian grass, and are called *grass mats*; and a still finer kind, or, rather, rugs, are made of the skins of sheep with the wool on, dyed and prepared. Besides these, there are merino fringe mats, fancy and worsted mats, Lapland skin, &c.

1075. *The skins of sheep and lambs, with the wool on, are made into rugs* by a patent process, which we shall describe as one that may be found useful in certain situations. The skins, with the wool on, are thoroughly cleansed from all impurities and foreign matter that may adhere to them by washing in running water, and by scraping the flesh side, in the usual manner, by the knife, and by cutting off all the extraneous and ragged parts, when they are ready to be tanned; for that purpose they are stretched upon frames, and laid upon tressels with the flesh side upward: an infusion of sumach, in the proportion of one pound to a gallon of water, is then poured over the skin, and the tanning matter is worked into the pores of the skin by the aid of the knife. When dry, the reverse, or wool side of the skin, is next placed upward, and thoroughly washed with a strong alkaline lye, or soap and water, and afterward in clean water, by which means the grease and filth are removed; when dry, the skin undergoes a second operation of tanning with sumach, as before mentioned, and, after being dried, its harsh and rigid surface is rendered smooth and soft by rubbing it over with pumice-stone. In order to dye it of any colour, before it is taken off the frame its face or woolly part is dipped into a bath of the required tint, prepared in the ordinary manner for dying wool; the washing must now again be repeated to get rid of the excess of colouring matter which adheres to it. The skins are then dried, and trimmed to the proper shape.

SECT. IV.—FLOOR-CLOTH, AND OIL-CLOTH COVERS.

1076. *This name of floor-cloth is applied to a manufacture of cloth painted over with oil colours, so as to be impenetrable to wet:* and the oil-cloth coverings used for tables, &c., are made nearly in a similar manner. A stout canvass is chosen, in the first instance, for floor-cloth, and this is sometimes of very large size, amounting to 210 or 220 square yards, which is the reason of the large premises required for this sort of manufacture. The canvass is stretched on a strong wooden frame, and, after being well sized, is rubbed and smoothed down with pumice-stone. Four coats of stiff oil paint are then laid on successively, on one side of the canvass, suffering each first to dry, and then three coats on the other side. After this paint is quite dry, the cloth is detached from the frame, in order to be printed in the manner of calico printing: for this purpose it is rolled up on a roller, and unrolled as required for the process. In giving the surface pattern, stencilling was formerly employed; but printing with blocks is now generally practised. The colours employed in good floor-cloth are always white-lead mixed with ochre, umbers, and the usual earthy pigments ground in linseed oil, and mixed with a little turpentine. In spurious oil-cloth whiting is sometimes mixed with the white-lead, but such cloth cracks and does not wear well. It is obvious that the number of blocks must depend upon the pattern: the greater the number of colours, the more expensive will be the manufacture. It is reckoned that every square yard of good floor-cloth should weigh 3½ or 4½ lbs., and hence the quality of the cloth may, in part, be estimated by the weight. Good cloth, when used for covering verandas, or other places exposed to the weather, ought to last nine or ten years; whereas, cloth of a spurious kind will decay in one year. The best cloth has even been occasionally used in some places for gutters, water producing no injurious effect upon it.

1077. *Floor-cloth is better for being kept for some considerable time before it is used*, the paint getting harder, and it, therefore, is charged for partly according to its age; new floor-cloth being cheaper than that which has been kept a year or two. That for passages is charged according to the yard run; yard wide is from 3s. 6d. to 5s. Half a yard wide, in the Persian or Turkish style of design, 1s. 6d. per yard; five eighths 1s. 7d.

Floor-cloth to cover a room is charged by the yard superficial, according to its quality, that depending upon the strength and goodness of the canvass, the number of coats of paint, the number of colours in the face, and the age of the cloth.

1078. *Floor-cloth is very useful in some apartments*, on account of its impenetrability to water, and its drying so soon after being wetted; but water should be sparingly used in cleaning it, and still more should soap, for this latter will cause the paint to come off by dissolving the oil with which it was made. If not too much dirtied, floor-cloth may be kept clean by wiping it with a damp cloth, and afterward rubbing it well with a dry cloth, and then with a brush till it shines.

1079. *There is a great variety of styles in the patterns of oil-cloth.* Some are made to imitate marble casements; some wainscot boards, and some carpets of various kinds. Those are best which have several colours, and the pattern rather small. When the pattern is large, defects are sooner perceived; but, again, in those which have a large pattern to imitate marble, defects may be repaired by a house painter.

1080. *Matting* is used in some cases instead of carpets. The best are India mats, which are used to lay over carpets, particularly in summer, from their being cool. They are durable.

1081. *Oil-cloths for covering tables* are made on fine canvass; one side, after having received the proper number of coats of oil paint, is printed with blocks; and the other side, next to the table, receives only one coat of paint, which, while wet, is strewed over with flock made of cut wool, so as to resemble green baize.

Sect. V.—Tables and Stands.

1082. *Dining-tables* are necessarily of various sizes and forms, to suit the apartments, number of guests, and other circumstances. Various methods have been contrived for increasing the size of tables on occasion, and of causing them to occupy less space when out of use. One of the most usual is the common dining-table, made of mahogany, with a fixed centre part, and folding leaves or flaps supported by fly-rails and legs to draw out, or put back when the table is placed at the side of the apartment. These tables may be square or round, as *fig*. 176. A variety of them, called a *cottage* dining-table, has the fixed centre not above 18 inches wide, to take up as little room as possible when put away.

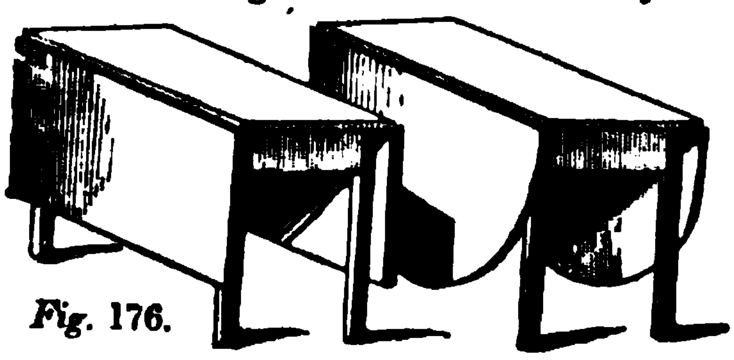


Fig. 176.

1083. *A square table may be increased* to an oblong one, by having fly brackets, as in *fig*. 177, on which may be laid loose flaps, one of which is represented in its place in the figure. These flaps are fixed in their places by pegs that drop into holes in the brackets; and they may be strengthened by projecting iron straps let into the table below the top. A thin rail may be put on with hinges to fold down, and conceal the flaps when the table is to be square.

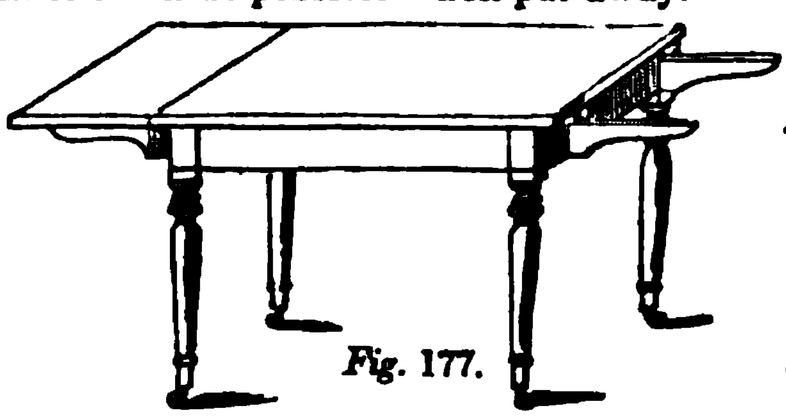


Fig. 177.

1084. *When a very long dining-table is required*, the usual method is to have the table that generally stands in the centre of the dining-room, whether square or round, as *fig*. 178, so contrived that it separates in two, as in *fig*. 179, and having loose flaps placed between supported by slides, called lopers, that draw out, forming a series of joists; the whole still resting only upon the four legs of the original table: this method is extremely convenient, as it prevents any

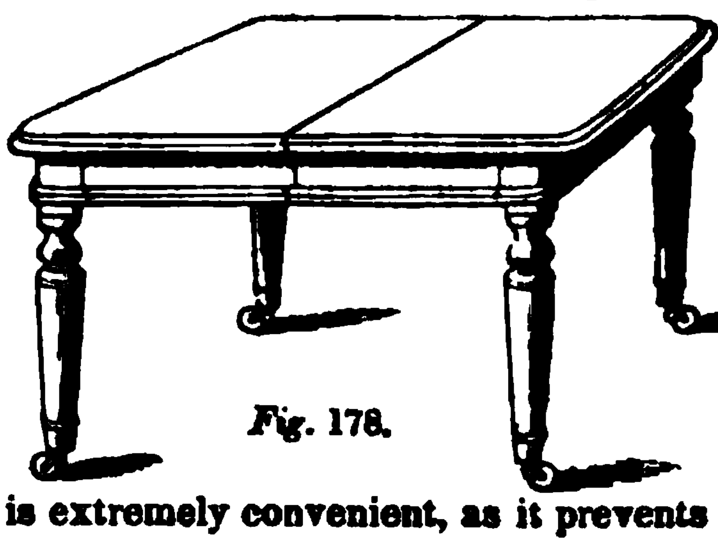


Fig. 178.

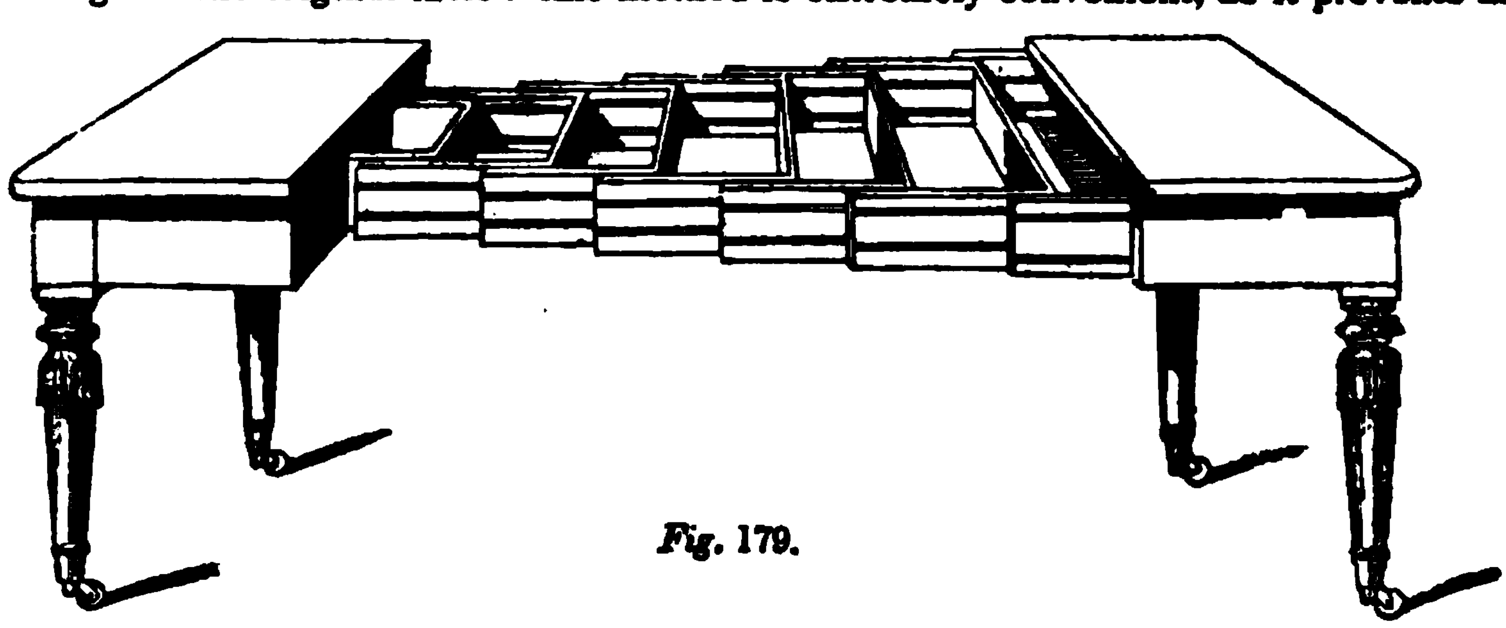


Fig. 179.

more legs coming in the way of the guests. These are sometimes termed *telescope tables*. In this manner a table may be made nine feet long, and without requiring any additional support; and one advantage of this construction is, that it obviates the inconvenience which frequently arises when the feet are numerous, and the floor not perfectly level. The flaps, when not used, are kept in cases made on purpose, and placed in an adjoining room, or a receptacle may be contrived for them in a sideboard. It is essential that the case in which they are kept should have openings to admit a free circulation of air, otherwise the flaps are apt to warp or decay, and slips, lined with green baize, should be fixed in the case to prevent the flaps rubbing against each other, or being scratched in taking out and putting in. On particular and temporary occasions, when no proper tables are at hand, boards laid upon *tressels* form a good substitute, as in *fig*. 180.

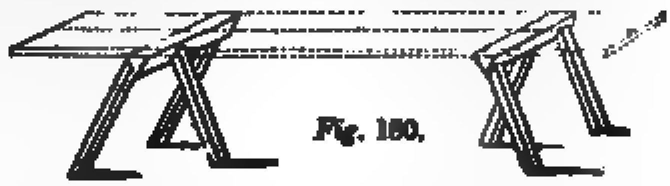


Fig. 180.

1065. *Pembroke tables* are well-known convenient furniture, frequently used as small breakfast or dining tables, *fig*. 181. It is requisite that they should be made of well-seasoned mahogany, otherwise, from the lightness of their structure, they soon become

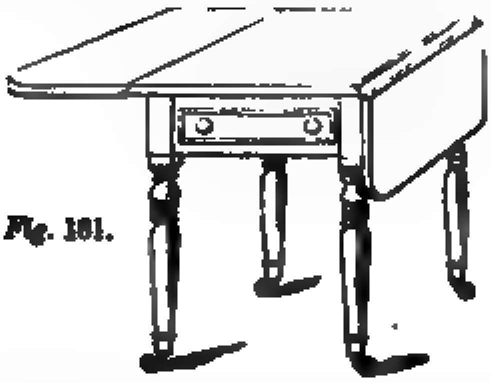


Fig. 181.

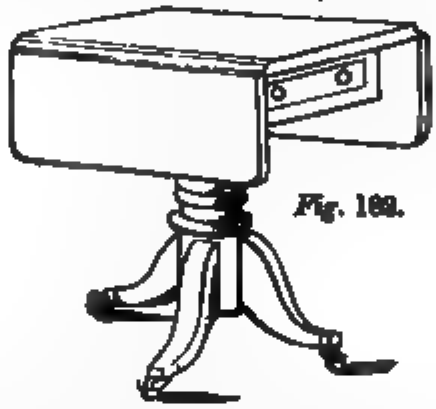


Fig. 182.

rickety: on this account, frequently, they can be most depended upon after they have been used for some time. It is now generally found best to execute them more substantially than formerly, when their lightness was thought to add to their elegance, as in *fig*. 182, which is a Pembroke table of a firmer kind, with pillar and three claw feet: this, as has been stated, makes the table steadier on an uneven floor, than when there are four feet.

1066. *Large round tables, as loo-tables, fig*. 183, are made with the pillar extremely strong. *Fig*. 184 is a square table with a similar pillar.

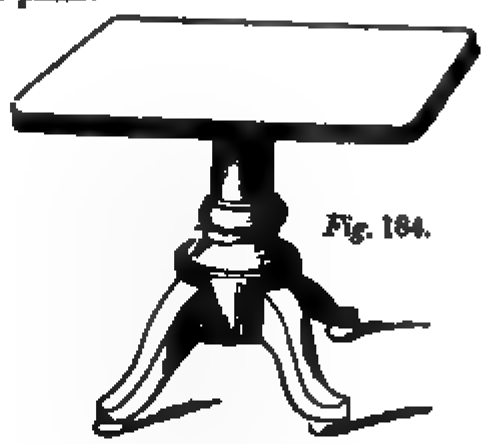
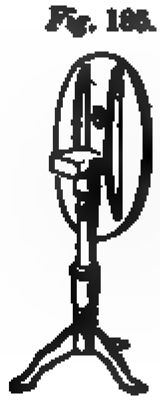


Fig. 184.

1067. *Small breakfast-tables, to take up little room*, are sometimes made to fold, as in *fig*. 185. Made larger, and with the supporting pillar very stout, they may serve for small dining-tables, as *figs*. 186, 187.

Fig. 185.



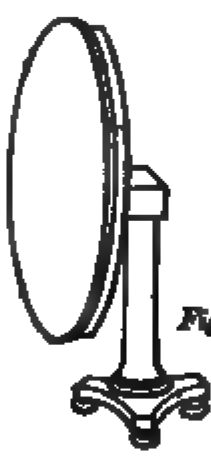


Fig. 186.

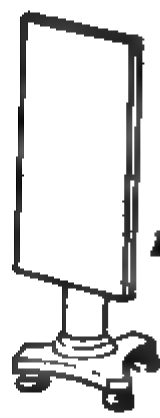


Fig. 187.

1668. *Library-tables* require to be made very firm and solid. The top is usually covered with leather for writing on. *Fig.* 188 is one with four legs turned and carved as required. Large drawers are convenient for holding portfolios or a large atlas.

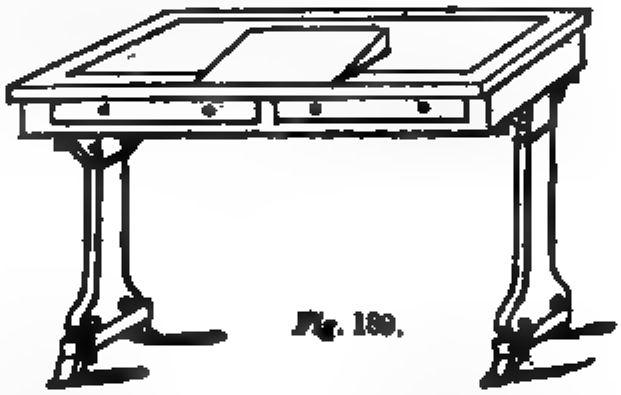


Fig. 189.

Fig. 189 is one of a more elegant construction. A moveable desk may be used for writing on.

Fig. 190 is a pedestal library table; the numerous small drawers are convenient for holding papers. Part of the top may be made to lift up as a desk, to write on; and a shallow drawer may pull out on the right to hold ink, pens, &c., and also a shelf may be made to draw out on the left, to increase the size of the top on occasions. It would be a convenient addition, though not usual, to have a cover hinged to the back, as represented in the cut, so as to shut over the top entirely, for the purpose of securing everything on it occasionally with a lock, without disturbing or putting them away, and this cover, when laid back, would be useful to give more room for holding papers. This table might likewise be made with doors to cover all the drawers, in which case, one lock and key would serve the whole, or one side might be fitted up for portfolios or large books, maps, &c. It is needless to observe that this place may be made more ornamental if required.

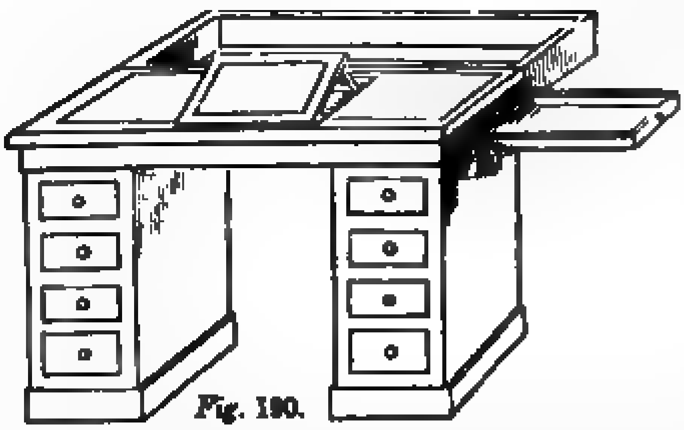


Fig. 190.

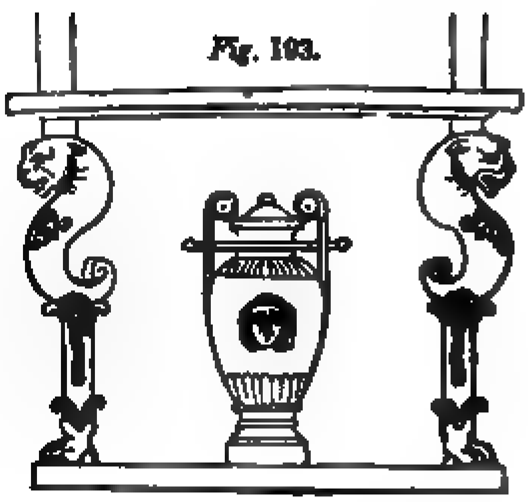


Fig. 193.

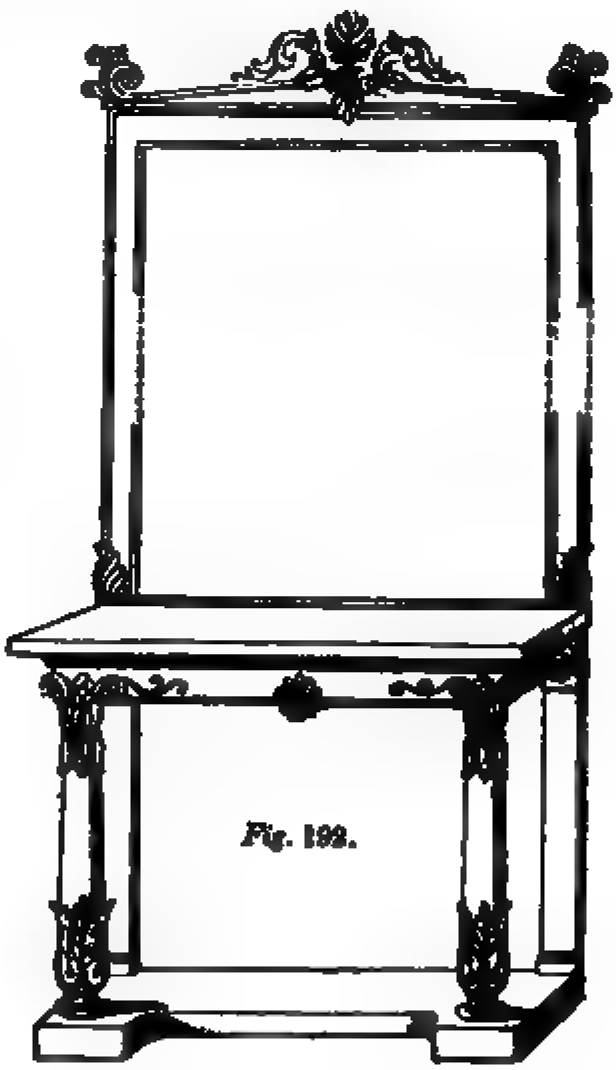


Fig. 192.

1089. *Pier-tables* are those which are placed against the piers between the windows; the tops are generally formed of some precious marble or scagliola. When the slab of the pier-table is supported by what is termed in architecture a *consol*, it is called a *consol-table*, as in *fig.* 191 Pier-tables are likewise supported by short columns or grotesques, as in *fig.* 192 and 193, and sometimes they contain cabinets or book-shelves. Frequently ornamental vases, or other objects of vertu, are placed upon them. If there are mirrors in the apartment, they are best placed over the pier-tables, as in *fig.* 192, because the light from the windows, coming full on the face, is reflected in the mirror. When the style of Louis XIV. is adopted in the apartment, the pier-tables and mirrors must be in the same style.

1090. *Card-tables* were formerly made, as *fig.* 194, with the top to fold, one half of which was supported by two of the legs, which were made to turn out. *Figs.* 195 and 196 represent a modern and improved construction, by which they can likewise have the top to fold, but may stand upon a single pillar. The folding top is made to revolve upon the frame, until it comes at right angles to its former position, when it exposes a well in the frame, in which the cards, &c., are kept; and it is then opened, being supported by the frame, which it entirely covers. These card-tables are, therefore, capable of every kind of embellishment as well as any occasional tables, and there is nothing in their appearance to distinguish them particularly from other tables.

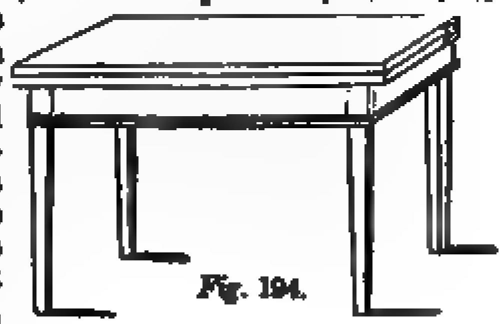


Fig. 194.

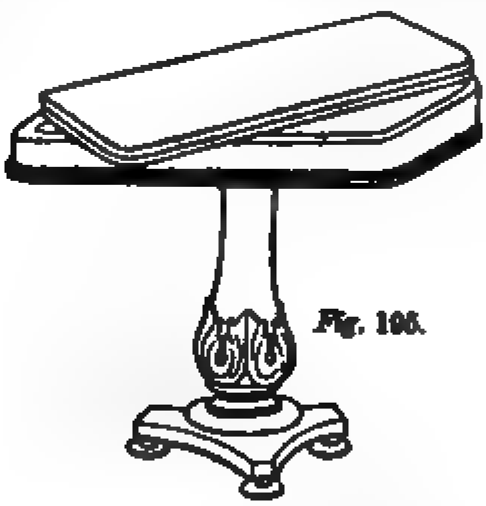


Fig. 195.

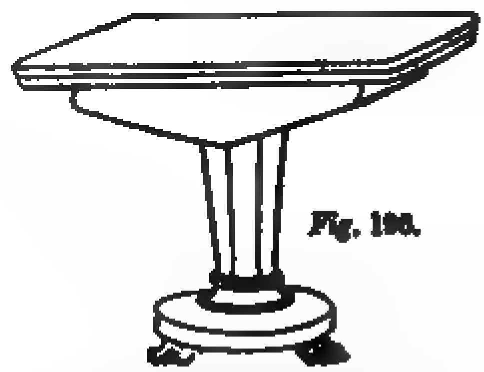


Fig. 196.

1091. *Sofa-tables* are elegant small tables for the drawing room, of a convenient form, as their name implies, to be placed near the sofa, and, for this purpose, are long and narrow. They are always made of fine woods, and considerably enriched by carving.

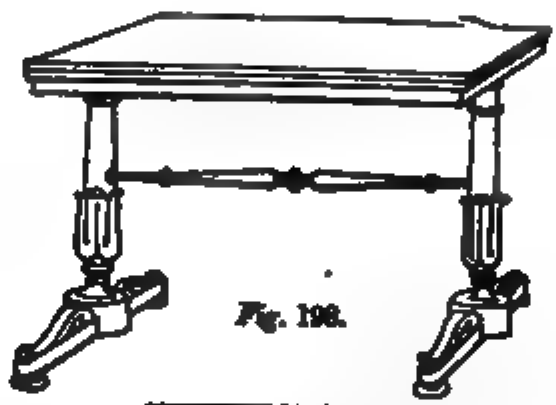


Fig. 198.

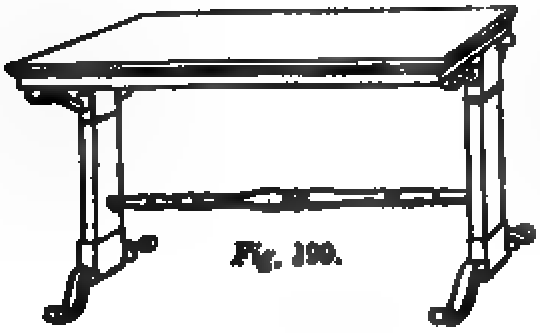


Fig. 199.

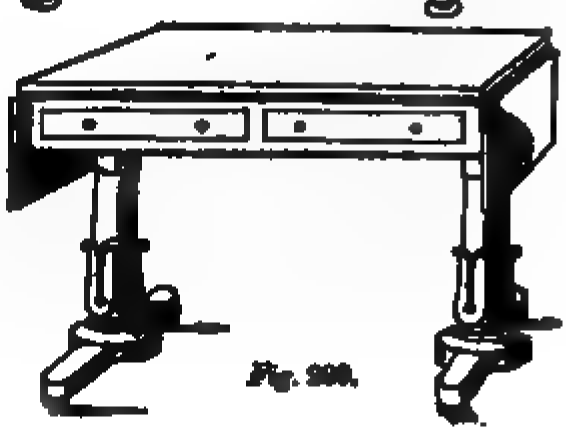


Fig. 200.

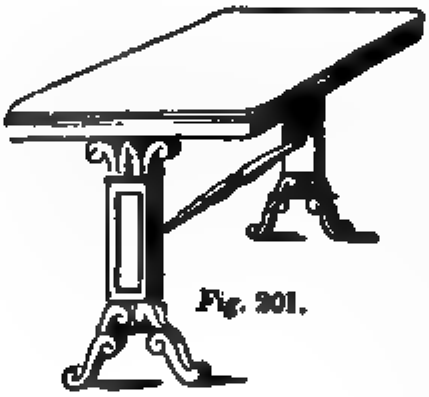


Fig. 201.

inlaying, or other modes of ornamenting. *Figs* 197, 198, 199, 200, 201, are various tables now in use of this kind. They are sometimes termed *occasional tables*, and made also circular or octagonal, and supported by a single stem, as *figs*. 202, 203, 204. Some have been lately introduced with the tops of slate, richly painted or japanned with various fanciful ornaments, slate having the advantages of not warping, and bearing the necessary degree of heat for a superior japanning process.

1092. *Billiard-tables* are frequent pieces of furniture in the villas, where they are used for exercise. They are usually placed in a room devoted to that use. As

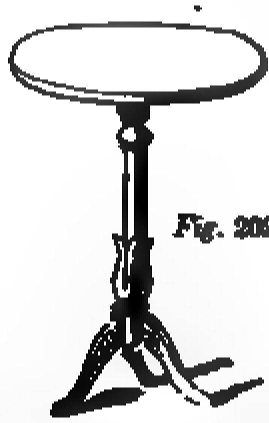


Fig. 202.

Fig. 203.

Fig. 204.

it is of great consequence that the table-top shall be quite level, great care is employed in fixing it. Sometimes spirit levels are attached to it, with screws for adjusting the top to a perfect level. They are usually made of mahogany, covered with green cloth; but they are also made of cast iron, and of slate.

Figs. 205, 206, 207, 208, are tables in the style of Elizabethan furniture.

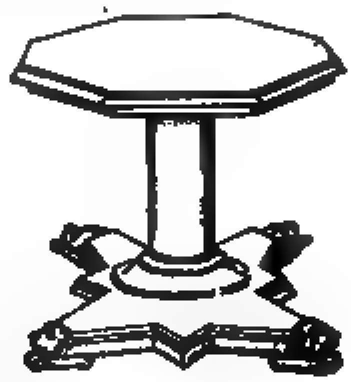


Fig. 206.

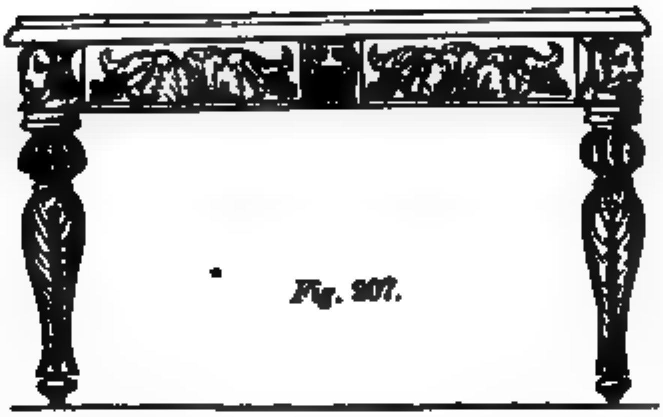


Fig. 207.

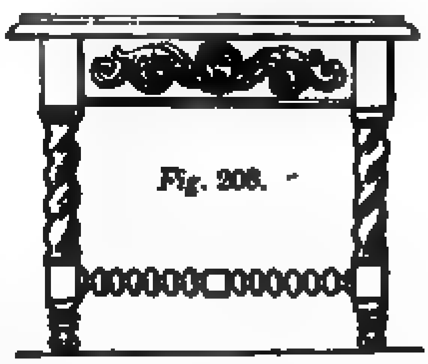


Fig. 208.

1093. *Ladies' work-tables* are small tables for holding the lighter articles of their work, and are generally fitted up with convenient places for cottons, needles, pins, scissors, &c. They are sometimes plain, of mahogany, with small drawers, as *fig*. 209, or with a silk bag fluted with a fringe, as *fig*. 210, fixed to a frame that draws out, for holding various articles of needle-work that are in progress.

1094. *Fig*. 211 is a larger one, made in the style of a sofa-table; and *fig*. 212 is a very small one of a circular form.

1095. *Fig*. 213 is a work-table combined with one for writing or drawing, and contains, besides the usual bag, a desk to raise up for reading, with convenient places for writing or drawing materials, with a sliding shelf at the side.

1096. *Fig*. 214 is a small work-table, the top of which is made to rise up to get at the

10.

Fig.

Fig. 212.

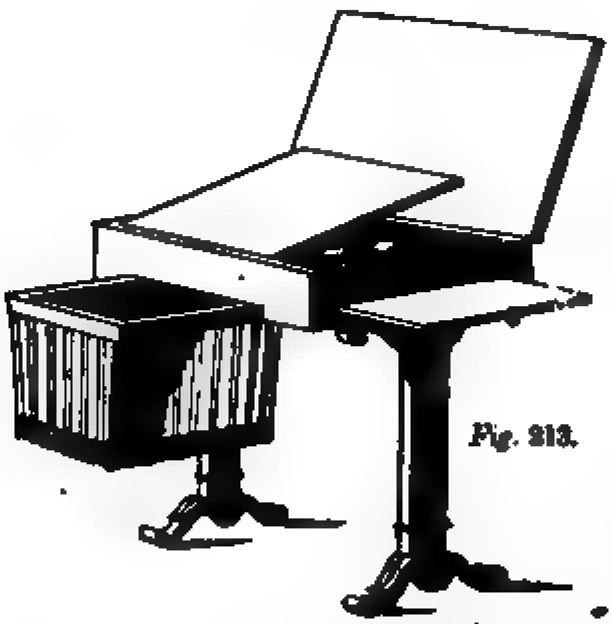


Fig. 213.

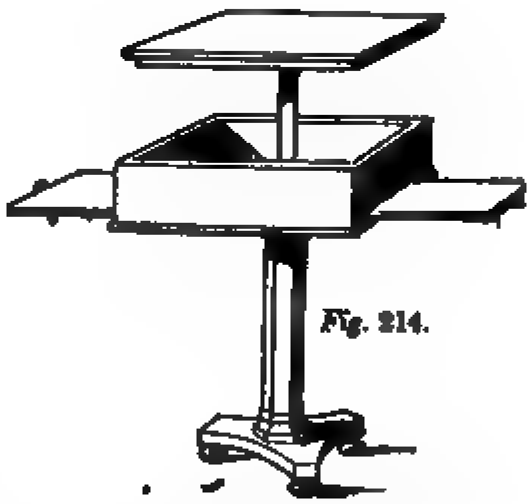


Fig. 214.

things kept in the table, without disturbing what is on the top: the top may be made in the manner of a revolving card-table, to produce the same effect.

1097. Extremely small stands for holding work are occasionally useful; *fig.* 215 is one of the least possible size; and *fig.* 216 is another convenient stand.

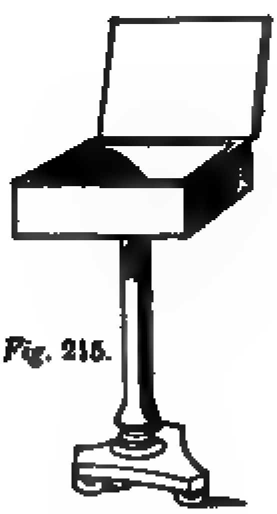


Fig. 215.

Fig. 216.

Fig. 217.

Fig. 218.

1098. *Work-boxes and baskets* are made of an infinite variety of forms, and are recom-

mended to be large enough to hold a moderate supply of work and all its requisites, without being of such a size as to be inconvenient for carrying about or lifting with ease. They should contain divisions or partitions, like the work-tables, to keep every thing in its place; but sometimes an error is committed in over partitioning, which creates trouble instead of avoiding it. The contents of such boxes or the necessaries for work, are too well known to require enumeration in this place.

1099. *Basket-stands, figs.* 217, 218, are now much in fashion.

1100. *What-not* is a whimsical appellation for a very convenient stand of several stories. *Figs.* 219, 220, 221, are various forms of them. The latter, in particular, admits of great elegance.

Fig. 220.

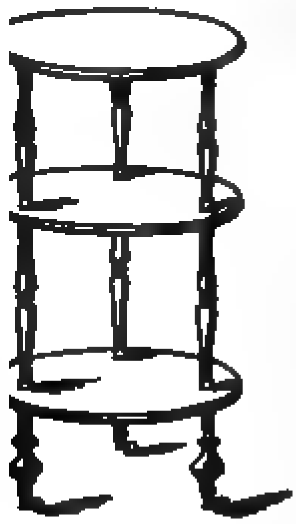


Fig. 221.

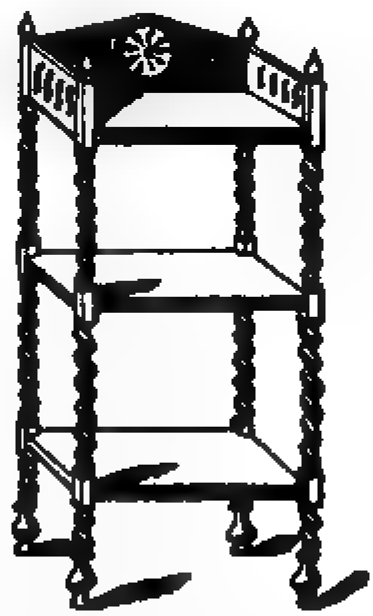


Fig. 222.

Fig. 223.

1101. *The tea-poise* is a small stand for keeping various kinds of tea in the drawing-room, ready for use. It is sometimes made with a rising top, and the various canisters are arranged within. *Figs.* 222, 223.

1102. *Small stands of very elegant forms* are useful appendages to furniture, for placing ornaments of sculpture and other objects upon, as well as to serve instead of tables on occasions that take up little room; for example, the want of a stand to hold a candlestick in a perpendicular place is often much felt. *Fig.* 224 will answer this purpose, as it is made to raise or lower. *Fig.* 225 is intended to support something heavy. *Fig.* 226 is a light stand of bronze or cast iron, resembling an antique tripod. *Figs.* 227, 228, 229, 230, are various stands of marble or scagliola to support objects of vertu.

Fig. 224.

Fig. :

g. 226.

1103. *Music-stands* are usually made with branches to hold candles, and to rise and fall like a desk. *Fig.* 231.

Fig. 227.

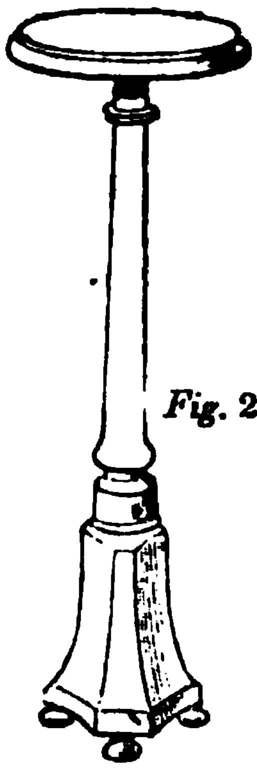


Fig. 228.

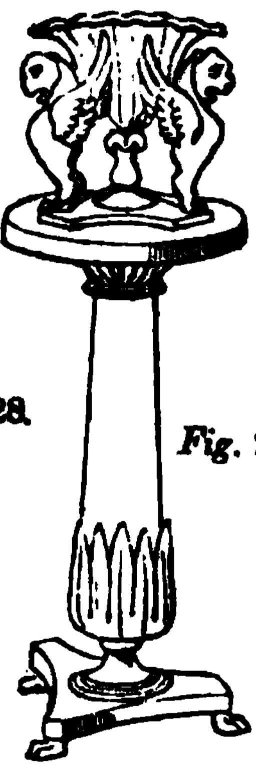


Fig. 229.

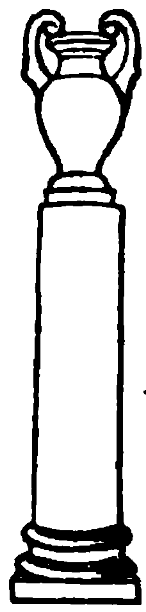


Fig. 230.

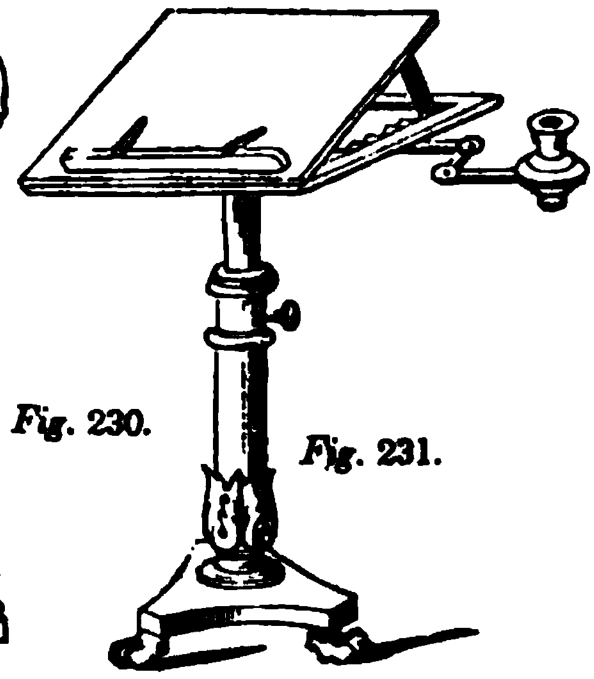


Fig. 231.

1104. *Flowers are employed to decorate apartments* in various ways. They are kept either growing in flower-pots, or in water, after having been gathered. The common red earthen flower-pot with a saucer is well known; but there are likewise some made of finer earthenware, a more ornamental kind. The latest improvement is by making them in form of a handsome vase, the lower part of which forms the receptacle for the water, which was first done by Wedgewood. *Fig.* 232 represents a section; *a*, *b*, is the lower part containing the water; into this is placed the flower-pot itself containing the earth, and the appearance of a saucer is done away with. *Fig.* 233 is the improved form given to these flower-pots at the lately-established potteries at Lowesby, in Leicestershire, and are painted in the style of the Etruscan and other antique vases. Large flower-pots in rooms are usually placed within a box of wood on concealed casters. When flowers are kept in bean-pots, they begin to droop and fade after being twenty-four hours in water: a few may be revived by substituting fresh water, but all may be a little restored by putting one third of the stems into warm water: by the time this water has become cold, the flowers will be erect and fresh; then cut off the ends of the stems, and place them in cold water, by which they may be kept a day or two longer. A great many flowers may be completely dried, with all their colours preserved, by burying them for some time in hot sand. In this process, the flowers are placed erect in a vessel capable of bearing heat, and hot sand is poured around them, but so as not to disturb their shapes. They are then kept in an oven gently heated till they are thoroughly dried. Groups prepared in this way are sold in Covent Garden market, and are very pretty.

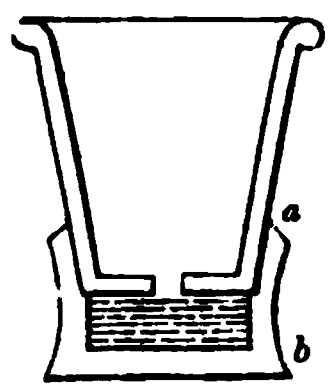


Fig. 232.

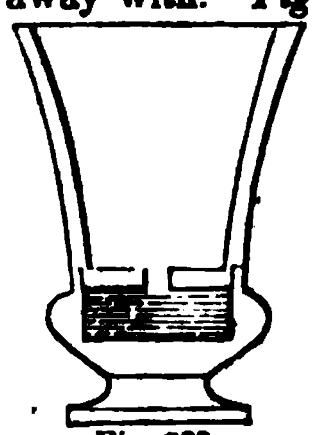


Fig. 233.

1105. *The flowering of bulbous roots* in water-glasses is likewise an agreeable manner of ornamenting apartments.

It has been lately discovered that many plants, particularly ferns, may be kept growing in an apartment, without any watering, by being planted in a box, and enclosed in glass. Plants have even been brought from India, in a growing state, by this contrivance, though the effect appears to be contrary to our usual experience.

1106. *Flowers should never be kept in bed-chambers* or nurseries, as they give out carbonic acid during the night, and consequently injure the air of the apartment.

Fig. 234.

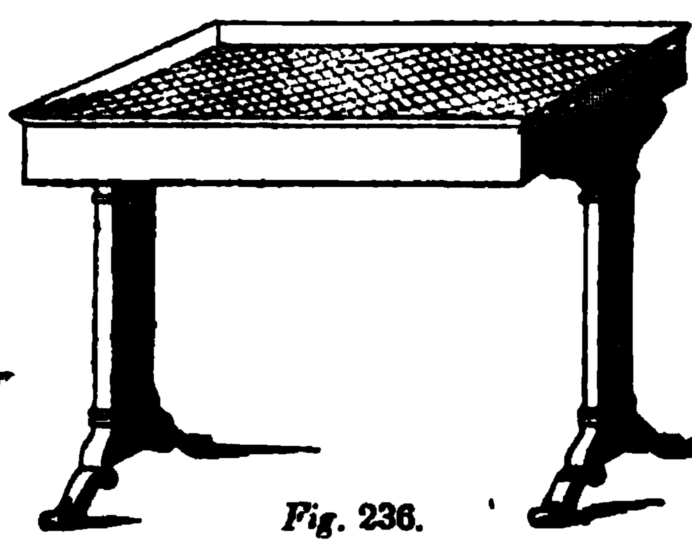


Fig. 236.

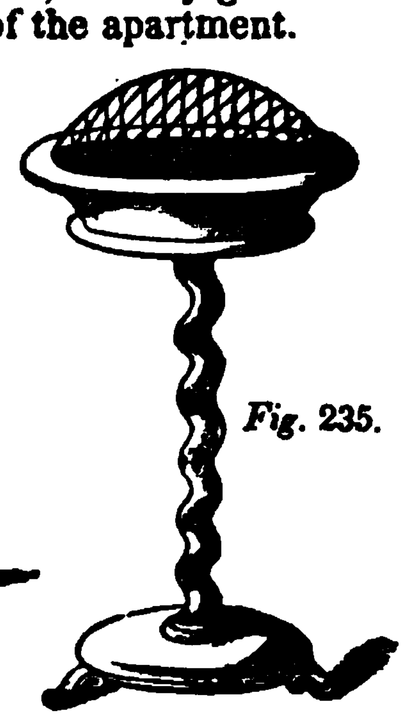


Fig. 235.

1107. *Flower-stands*, called *jardinières*, are for keeping cut flowers fresh for some time, by putting them into wet sand, kept in a japanned tin tray that fits on the top of the stand. This is covered with a trellis-work of wire or pierced tin, in the apertures of which the stems of the flowers are put to keep them upright.

Fig 234 is a small stand of this kind to be placed on a table. *Fig*. 235 is a small one to stand on the floor. *Fig*. 236 is a larger one. *Fig*. 237 is a stand for a flower-pot. *Fig*. 238 is a stand for several flower-pots. *Figs*. 239 and 240 are smaller stands for flower-pots. In *fig*. 240 the pots are concealed by moss.

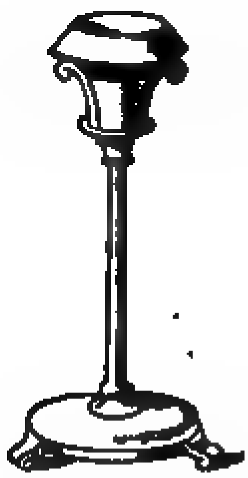


Fig. 237.

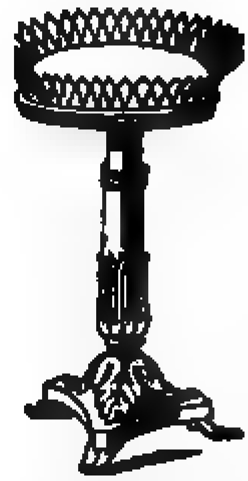


Fig. 239.

Fig. 241 is an economical stand for cut flowers, made of tin and wire painted. When full, it forms a pyramid of flowers.

1108. *The pot-pourri*, so called by the French, is made by combining the odours of various flowers, by putting their petals into vases or china jars placed in apartments. For this purpose, a great variety of flowers are employed, as orange flowers, rose leaves, pinks, marjoram, thyme, lavender, rosemary, camomile, melilot, sweet basil, balm, jasmine, &c. These are mixed together, and some salt is added, and well stirred among them to preserve them; the perfume will last for many months; and sometimes odoriferous gums are added, as benzoin, and, in short, any sweet-smelling substances, as cinnamon, musk, &c., which may compound such a perfume as is most agreeable. The jars are kept covered, except when the perfume is wanted.

An English pot-pourri is described as consisting of violets, jasmine, lavender, clove-gilly flowers, rosemary flowers, knotted marjoram, balm of Gilead, damask roses, orris root, gum benjamin and storax, musk, cloves.

Another, orange flowers, clove-gilly flowers, damask roses, knotted marjoram, lemon thyme, rosemary, mint, lavender, rind of lemon, cloves, all chopped and salt between. If the whole cannot be salted at once, put them in as they can be had.

Sect. VI.—SIDEBOARDS.

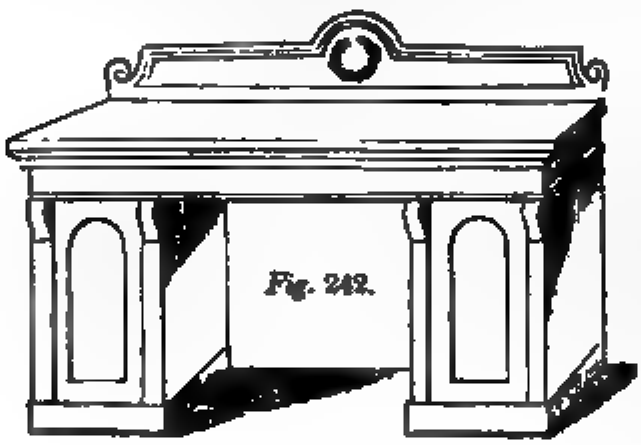


Fig. 242.

1109. *Sideboards* are generally made of fine mahogany, and more or less enriched with carving and other ornaments. Small sideboards are often of the kind called *pedestal sideboards*, *fig* 242, having on each side doors enclosing shelves or drawers for holding plate, liquors, or other similar articles; at the bottom may be a deep drawer with partitions. Some have likewise drawers under the top. *Fig* 242 is one in a very plain style. In the centre, underneath, is placed an open wine-cooler within, where that is used.

Fig. 243 is a sideboard of a more considerable size, and without shelves, as the last. They are usually made in this manner in large rooms, as they thus admit of great variety of ornament, and the table may be supported by columns, termini, caryatides, or

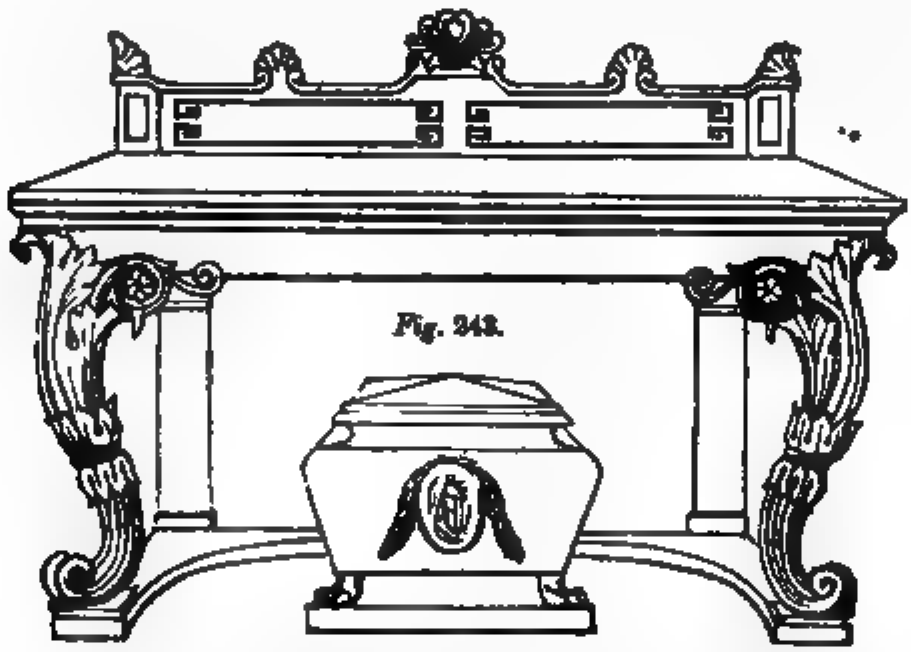


Fig. 243.

other appropriate objects. Beneath is a *cellaret*, or a receptacle for wine or liquors, &c., or it may be a wine-cooler. The cellaret is frequently made in the form of an antique sarcophagus. Sideboards are sometimes made with deep drawers to hold a cellaret. At present, the Louis Quatorze style is much employed for sideboards, or they are enriched by some ornaments in that style.

Fig. 244 is an example of the manner in which a sideboard is frequently made up out of dissected parts of Elizabethan furniture. The foliage of the carving in oak is in a very rich style; but the figures are uncouth, as they usually were in that period.

1110. *Chiffonnière* is a French term applied to certain low moveable pieces of furniture, serving as closets. They are generally made of an elegant form, and ornamented so as to suit a sitting-room, or even a drawing-room. Since fixed closets are out of fashion, these are particularly useful in small parlours, where they are often placed on the recesses on each side of the chimney, as a substitute for closets and a sideboard, and serve to hold wine, liquors, biscuits, or other refreshments; and on the top, and on a shelf supported by small pillows or brackets, are placed decanters, glasses, or ornaments. In large apartments, as in libraries, ladies' sitting-rooms, and even in drawing-rooms, they are very convenient for holding a number of things that are often wanted; and the top may be ornamented with flowers, vases, ornamental china, minerals, or beautiful objects of art or nature. In drawing-rooms they may be used instead

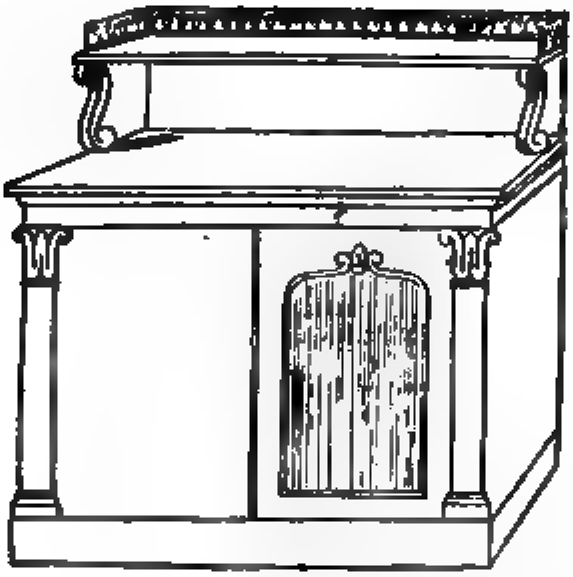


Fig. 245.

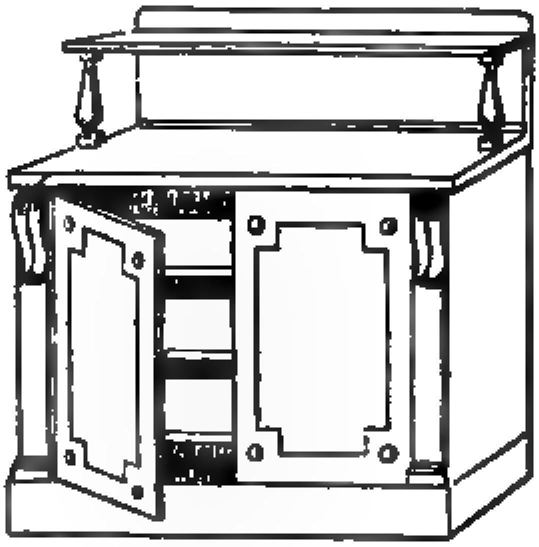


Fig. 246.

of pier-tables. *Figs.* 245 and 46 represent examples of the smaller kind, and *fig.* 247 is one larger for a drawing-room.

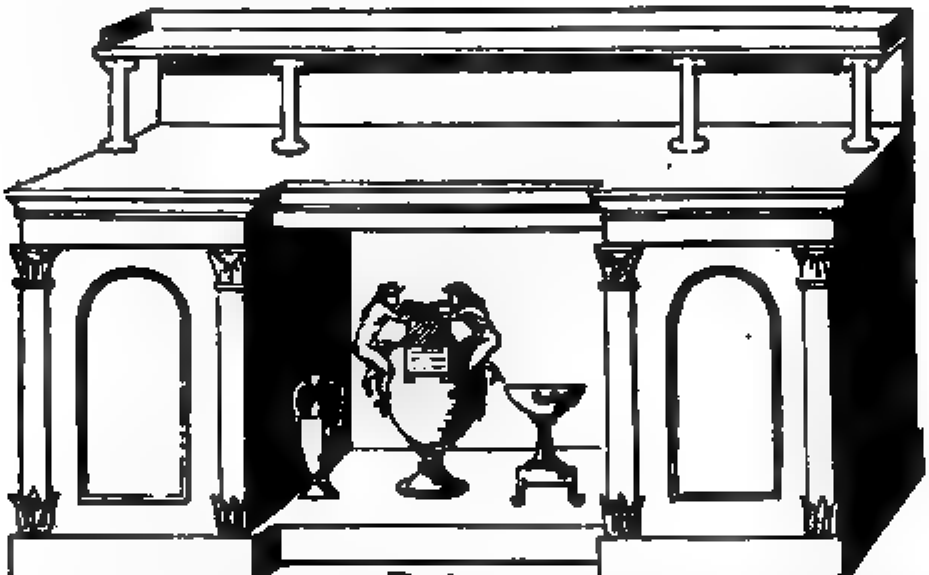


Fig. 247.

1111. *Moving sideboards, or wagon tables, figs.* 248, 249, are useful, when introduced into some convenient part of the dining-room during dinner, for holding various articles that may be wanted, or for placing plates, dishes, &c., upon to be taken away together; these tables being placed on casters to move easily and with no noise. *Figs.* 248 and 249 are usual forms of this piece of furniture.

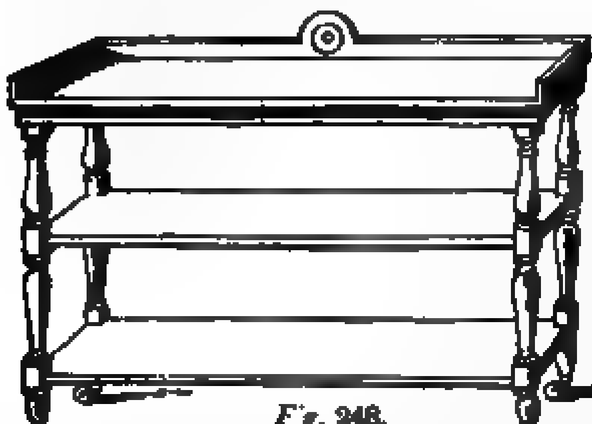


Fig. 248.

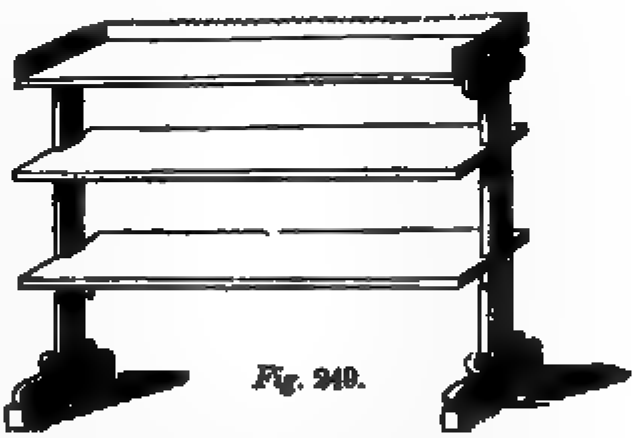


Fig. 249.

1112. *Rising tables, figs.* 250 and 251, are a late improvement. By a particular contrivance in the pillow, which is hollow, the top may be made to separate into three parts, so as to have the advantage of a dumb waiter; and when required to form a simple round table, the upper shelf can be depressed, and the lower one raised, so as to form only one top.

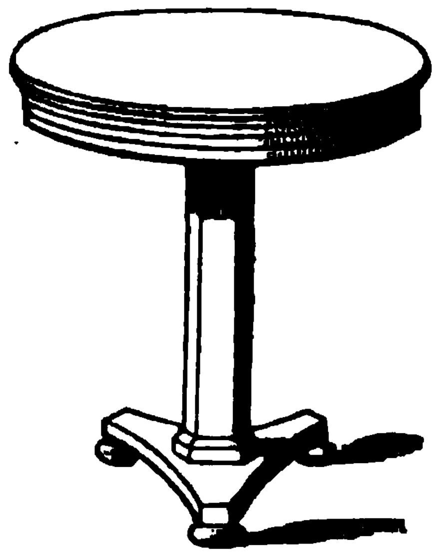


Fig. 250.

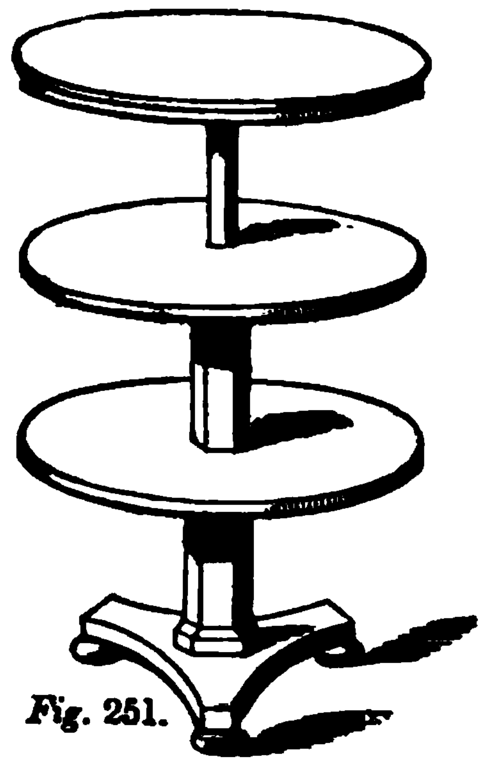


Fig. 251.

Fig. 252 *is a rising wagon-table*; by depressing the upper shelf, and raising the lower one, the whole forms an ordinary side table that may always remain in the room.

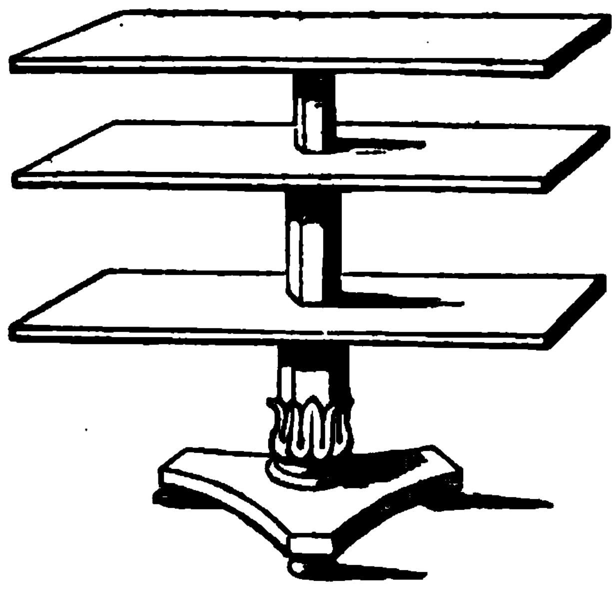


Fig. 252.

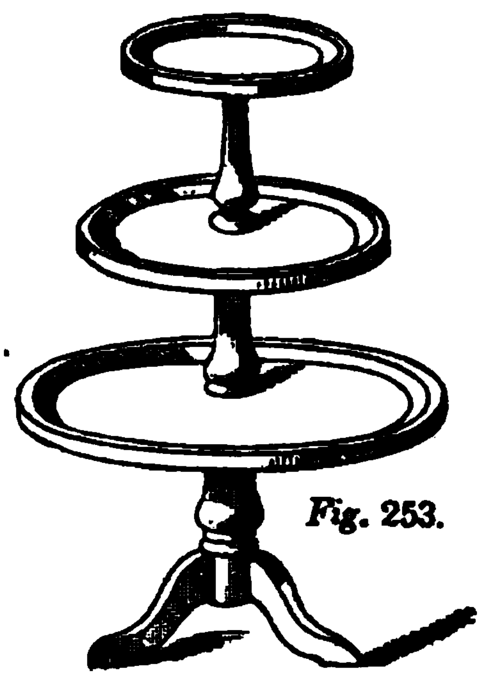


Fig. 253.

1113. *Dumb waiters*, *fig.* 253, are well known as a piece of furniture formerly much in use, and extremely convenient, but, being now out of fashion, and superseded by the rising tables, is rarely to be procured except at the broker's. The shelves should be made to turn round, which renders them particularly convenient.

1114. *A tray-stand*, *fig.* 254, formed of two frames and girth to fold up, is useful for supporting a tray during dinner in small apartments. To make this serve as a camp-table, or for pic-nic parties, an additional board may be provided with one leg fixed to it by a hinge to fold. This may be connected with the tray-stand by having two pins to insert into holes in the rail of the stand, with hooks and eyes to keep it fast. This board being of the same width as the stand, may pack up with it conveniently.

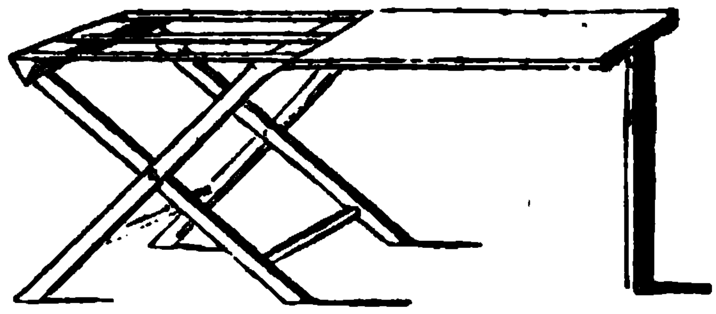


Fig. 254

Sect. VII.—SOFAS.

1115. *Sofas are articles of furniture that are not merely luxuries: they conduce much to comfort*; and, in our artificial state of society, are sometimes essential to health. The name is derived from *Sophi*, a title given to the Emperor of Persia. The sofa appears to be originally an eastern fashion, probably taken from the divan, which is a part of the floor raised a little above the rest in Turkish and Persian houses, and having a continued seat along the wall, covered with mattresses, about three feet wide. Persons of distinction have this seat covered with scarlet cloth, silk, or other rich stuffs; and there are likewise pillows stuffed with cotton, and covered with similar stuffs, to lean upon. As it is not the custom, in these countries, to use chairs, it is upon these they sit. It may be interesting to remark, by-the-way, that, although the custom we have mentioned is still general, yet we are informed by Mr. Spencer, the late traveller, that some of the Turkish grandees are beginning to evince a preference for European customs and furniture; and, instead of sitting on the ground and eating only with their fingers, are now making use of tables, chairs, knives, forks, and spoons, and furnishing their apartments with costly looking-glasses, chiffoniers, secretaries, chests of drawers,

&c.; and he suggests, as a profitable speculation, sending cargoes of furniture to Constantinople and other large Turkish towns.

Sofas with us are usually made of mahogany, enriched with carving, and covered with hair cloth, chintz, or silk. *Fig.* 255 is a drawing-room sofa in the Grecian style.

Fig. 256 is a couch sofa, which is somewhat less expensive.

Fig. 257 is one in the antique style, where a leopard's skin is used as a cover.

Figs. 258 and 259 are modern French *settees.*

1116. *Figs.* 260 and 261 are pieces of furniture lately introduced from France, and called *conversation chairs.* They are made to hold only two persons.

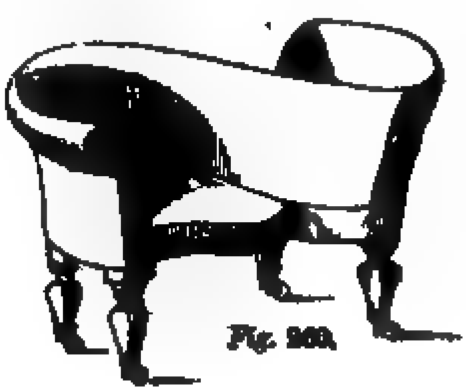


Fig. 260.

Fig. 261.

1117. *Ottomans* are stuffed seats placed along the walls in the Turkish manner, as in *fig.* 262, or they may be insulated, and placed in any part of the room, as in *fig.* 263. They are found extremely agreeable and convenient, and help to break the formality of the more important furniture. They are particularly useful in picture galleries, music-rooms, ante-rooms, &c.

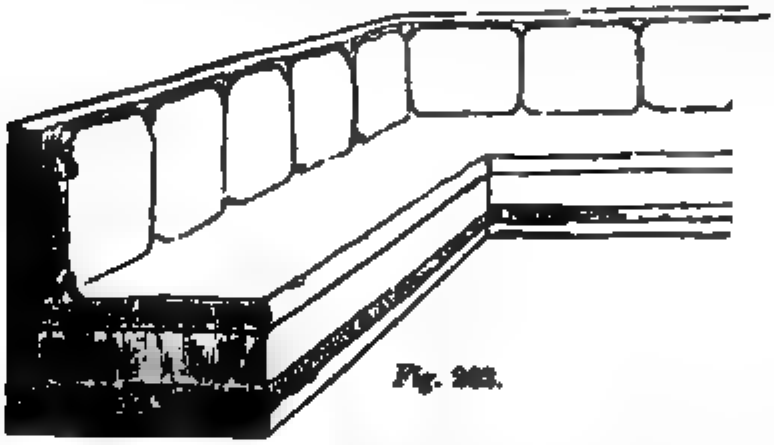


Fig. 262.

Fig. 263.

SECT. VIII.—CHAIRS AND SEATS.

1118. Scarcely any article of furniture has undergone so many changes, and admits of such variety of forms, as chairs. The use of a chair being for a seat, there are certain principles which should regulate its form, though these have been frequently ill understood, or interfered with by the fashion of the day. Independently of the elegance, the forms of chairs, on which depends the easiness of the seat, may not be an object of great consideration to persons who sit but little; but to those who are in the habit of sitting for many hours at a time, it is of the first importance that the shape of the chair be such that the weight of the body may not press unequally upon it. These principles appear to have been well understood by the ancient Egyptians and Greeks, since the forms of their chairs were simple, but admirably adapted to their purpose.

1119. *The French artists, with Mr. Hope, in copying or imitating the antique style,* produced some of the best chairs, the forms of which are still retained, or have given hints for the most perfect now in use.

Figs. 264, 265, 266, 267, 268, 269, 270, 271, 272 are chairs in the antique style.

Figs 264, 265, 266, 267 are from the designs of the late Mr. Hope, and are remarkable for their graceful shapes, and the comfort which they afford. The last five are arm-chairs. *Figs* 264, 266, and 267 have been much imitated for parlour chairs, and in some respects improved upon.

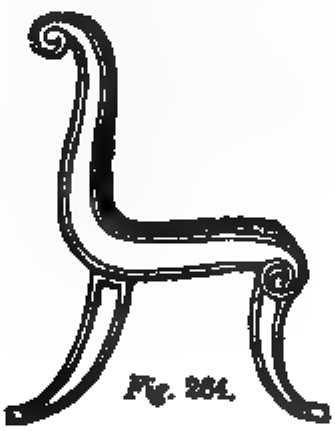


Fig. 264.

Fig. 265.

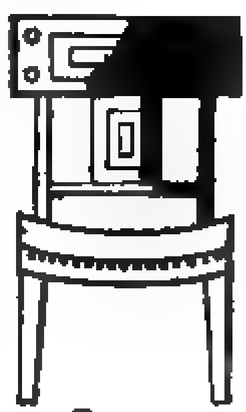


Fig. 266.

Fig. 267.

Fig. 268.

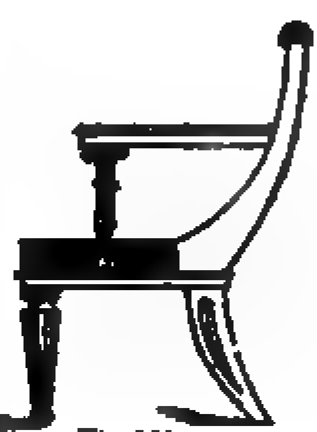


Fig. 269.

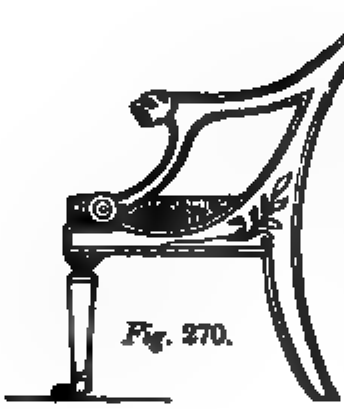


Fig. 270.

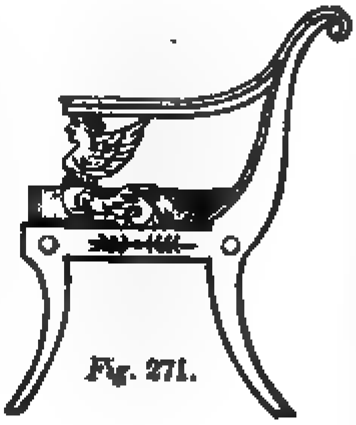
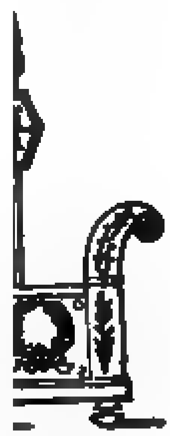


Fig. 271.

Fig. 272.

Fig. 273 is a group of furniture in the antique style from Mr. Hope's design.



1120. *Chairs judiciously designed should have* few sharp angles or straight lines, but should exhibit graceful curves, affording easy backs to lean against with, firm feet; and, in general, should be too heavy to lift and move about easily.

1121. *The seats of chairs* are generally stuffed with horse hair, or are made of split cane woven, or of rushes. In purchasing chairs it is necessary to ascertain whether the stuffing is really done with horse hair, as hair of very inferior kinds is frequently substituted, and sometimes it is mixed with wool, or even straw. The framing is also sometimes done with unseasoned wood, and becomes loose and rickety, on shrinking, by drying. It is therefore generally bad policy to purchase those that are offered on very low terms, as there is usually some imperfection.

1122. *In the cheapest kinds of chairs the legs* are held together by cross bars and rails; but in the best chairs these are omitted, the stoutness of the materials and goodness of the workmanship permitting the legs to be sufficiently strong without.

It is the custom to ornament the front legs of chairs by mouldings, and sometimes carving is added, whereas the back legs are plain. Some have objected to this difference, but it appears justified for several reasons. The front legs of mahogany chairs are usually made straight, as they are found inconvenient when curved, and when straight mouldings can be turned upon them by the lathe at a cheap rate; whereas the back legs, being curved, that the chair may stand firmer, cannot easily be turned, and carving on them would scarcely be seen: nor does there appear to be any reason why the front and back legs, being so different in shape, should be ornamented in the same manner, good taste requiring that labour shall not be thrown away. In light chairs for the drawing-room the front legs, as well as the back ones, are generally curved and decorated with mouldings, but they are usually made of woods that can be bent after they are turned, which mahogany does not admit of.

1123. *It will be most convenient to class chairs* according to the apartments in which they are placed; since this regulates not only their forms and style, but likewise the materials of which they are made.

1124. *Parlour chairs* are almost always made of mahogany, frequently French polished, with the seats stuffed with horse hair, and covered with morocco leather, plain or tufted, red, green, or blue, or with hair cloth. They should have little carving, should be of solid construction, and of forms agreeable to handle and move. The backs should not be too upright, but should be curved, and slope back, to afford an easy position to the body.

Fig. 274.

Figs. 274, 275, 276, 277, 278 are some of the most approved forms now in use. They should rather be a little massy and heavy than light. Those which are ill made and cheap are apt to break down when leaned upon, an accident not unattended with serious danger. Some have the backs stuffed in part.

1125. *Easy or arm chairs—Fauteuils.* Much pains and invention have been bestowed in contriving the forms that give the greatest degree of repose and support to the body in easy chairs; and this is not to be considered as mere luxury, since it is really of great importance that, after fatigue, the most perfect rest shall be enjoyed, as well as where delicate health demands indulgence. At the principal upholsterers a great variety of these may generally be seen, distinguished sometimes by the names of the inventors.

Some of the best of these are represented in *figs.* 279, 280, 281, 282, 283, 284; the last is called the shell chair. They are generally of mahogany; the stuffed part of morocco

leather, filled with the best horse hair, and tufted: occasionally the seats contain spiral steel springs for greater elasticity.

1126. *Drawing-room chairs. Figs.* 285, 286, 287, 288, 289, 290 admit of more carving and other ornaments than those for the parlour, and they are made of a lighter construction. Mahogany is sometimes the material; but now more frequently satin-wood, rose-wood, tulip, and other rare woods. Sometimes also they are beautifully japanned, or painted and gilded. The seats are covered with rich silk, and flowered satins, painted velvets, superfine cloth, worsted worked, or chintz, and at present it is the fashion to go to considerable expense in these chairs, when of the ornamental kind. Mixed with the more massy drawing-room chairs, it is now the custom to have a variety of others of a much simpler kind, and extremely light, usually termed *conversation* or *gossiping* chairs. These have the seats mostly of split cane or of rush. *Fig.* 291 is a chair of this kind of a French pattern: *fig.* 292 is Italian: *figs.* 293 and 294 are Swiss forms. Occasionally, some drawing-room chairs have the seats very low and the backs high; in short, more whim and caprice is shown in chairs than in any other article of furniture.

1127. *Library chairs* vary much with the taste and habits of the possessor, but have usually the plainness and solidity of those of the parlour or eating-room.

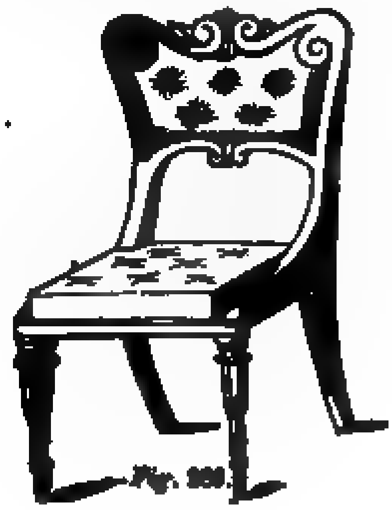


Fig. 286.

Fig. 287.

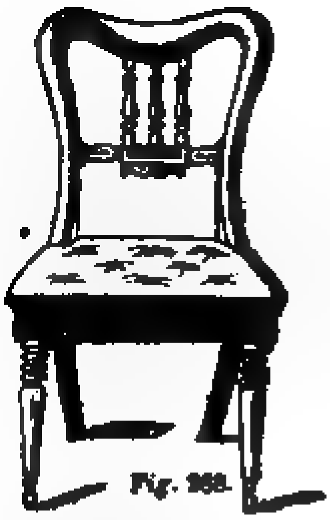


Fig. 290.

Fig. 291

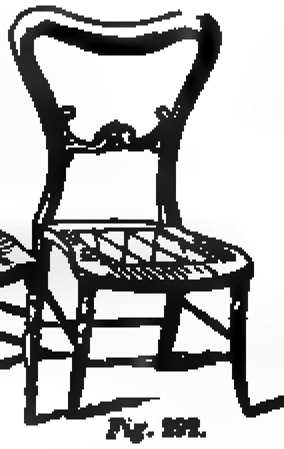


Fig. 292.

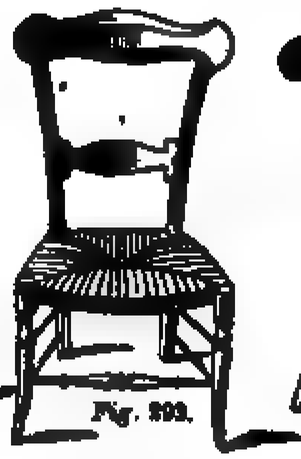


Fig. 293.

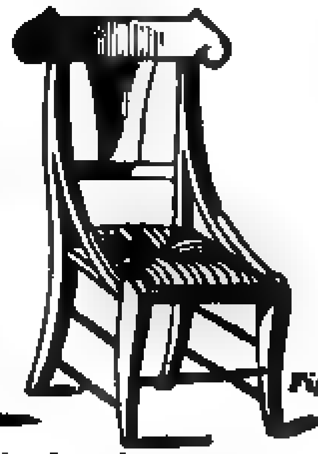


Fig. 294.

Figs. 295 and 296 are library or *summer chairs*, with cane back and seats.

Fig. 297 is called by upholsterers the *classical chair*: it is useful in the library, and possesses the advantage by the seat being made to revolve; the person sitting in it

Fig. 297.

may very easily turn himself round to speak to any one without shifting the place of his chair.

Fig. 298 is a *reading chair*, furnished with a stand for a candle and desk for a book.

1128. *The beehive chair*, *fig.* 299, made of straw, has been long used in Wales and Scotland, as well as in some places in the north of England; but it is only of late that they have appeared among our fashionable furniture. They are, however, warm and cheap, and are admired by some persons for their simple, homely, and snug appearance.

1129. *Figs.* 300, 301, 302, 303 *are examples of the so-called Elizabethan or Flemish chairs*, at present brought so much into fashion again. Some of them are remarkable for their high backs and low seats. The chairs are formed of oak or ebony, and the backs and seats of cane are stuffed and covered with rich silks, as damasks, tabarets, &c., or figured velvets, and sometimes ornamented with embroidery and fringes. In general, they had cross bars to strengthen the legs, although at present these are frequently omitted.

Fig. 301. *Fig.* 302.

1130. *Figs.* 304, 305, 306 are chairs in the same style, but with the backs lower Some of these are ornamented with a profusion of rich carving.

Fi

1131. *Fig*. 308 is an arm-chair of the same kind, the back and seat covered with red leather. *Fig*. 307 is a plainer chair, the back covered with stamped leather, put on with large brass-headed nails, the seat of striped stuff. *Fig*. 309 is a rich arm-chair of the time of James I., gilded, and covered with rich damask and fringe.

1132. *Fig*. 310 is the top of one of these chairs, to show the style of the carving more plainly.

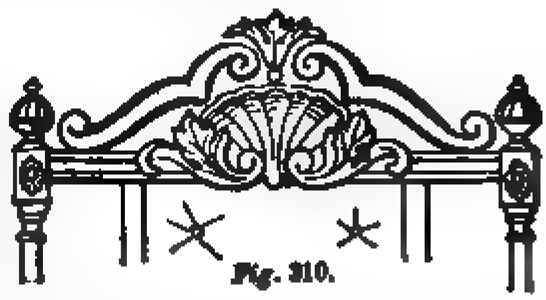


Fig. 310.

1133. We omit chairs *in the Gothic style*, as they are never used, except the house itself be in the same style; and we may observe that this style is, in general, very ill adapted for domestic furniture, and except it be designed by artists of great taste, and who are very well acquainted with Gothic architecture, and what little remains of ancient furniture, attempts at imitation are generally very miserable, besides being extremely expensive.

1134. *Figs*. 311, 312, 313, 314 are chairs in the *style of Louis XIV*. In these, frequently, a great part of the chairs is gilded, and the seats and backs covered with rich silks, figured stuffs, and velvets.

1135. *Drawing-room seats*, of a detached kind, are useful, in addition to the usual sofas and chairs, to place in any part of the room, for two persons to converse, or for similar uses. *Figs*. 315, 316, 317, 318, 319, are fashionable forms in the antique style. *Figs*. 316, 317, 318, and 319, sometimes called X-seats, may be of cast iron, or may contain a slight iron bar in the middle of the mahogany legs to strengthen them.

Fig. 315.

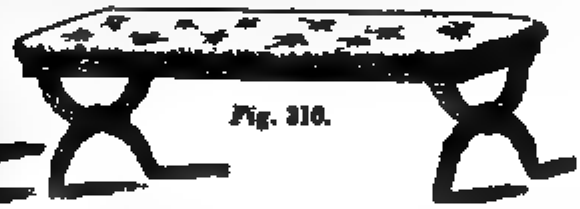


Fig. 316.

Fig. 317.

Fig. 318.

Fig. 319.

1136. *Music-stools* are made to raise or lower by means of a screw in the stem, *figs*. 320, 321.

Fig. 320.

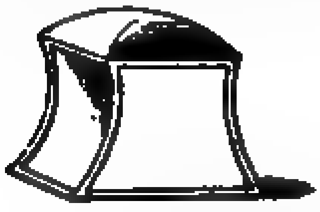
Fig. 321.

Fig. 322.

1137. *Figs.* 322, 323 are stools of a simple kind. *Fig.* 323 is a stool that generally forms a box, the lid of which is the seat; and it is often adorned with embroidery.

1138. *Footstools* are likewise necessary pieces of furniture, particularly where there is nursing of children: they are of many kinds. *Figs.* 324, 325, a usual form for the drawing-room; and *fig.* 325 is called an Ottoman footstool.

Fig. 324.



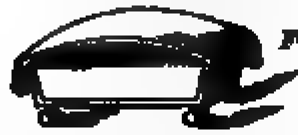


Fig. 325.

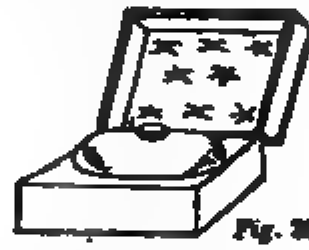


Fig. 322.

Fig. 326.

1139. *French foot-warmer.* This is a box containing a tin vessel, in which hot water is put, being carefully wadded round to keep in the heat; the lid is also wadded, *fig.* 326. This will keep warm some hours when shut, and is very useful to keep the feet on, when occasion requires it.

SECT. IX.—BOOKCASES, BOOKSTANDS, AND WRITING-DESKS.

1140. *Bookcases.* The most economical bookcases are simple shelves, filling up the side of a room, or a recess in it. When bookcases are detached pieces of furniture, and large, they are usually made with the lower part deeper, for folios and other large books, as in *fig.* 327; and this part may be shut up with close doors, one part containing drawers for prints or portfolios, or shelves for folio books. The projection of this lower part serves as a shelf to rest books upon. The upper part is generally fitted up with shelves to contain books of the quarto, octavo, and smaller sizes. There is usually more or less of architectural style in the design and ornament; though much of this should be avoided, and a plainer style, or one agreeing more in richness with the rest of the furniture, should be introduced in preference. The shelves should be made moveable, so as to be fixed at various distances from each other, according to the sizes of the books, which should be so arranged as to fill up the space nearly. A few wooden false books are useful to supply the place of those which are taken out, to prevent the rest from falling. In the country, bookcases may do very well without glazed doors, or with doors having only wire-work to secure the books; but in the large cities of Britain, close doors are indispensable, if it is desired to preserve the books from smoke and dust, which prove extremely destructive to them in the course of a few years. The wire-

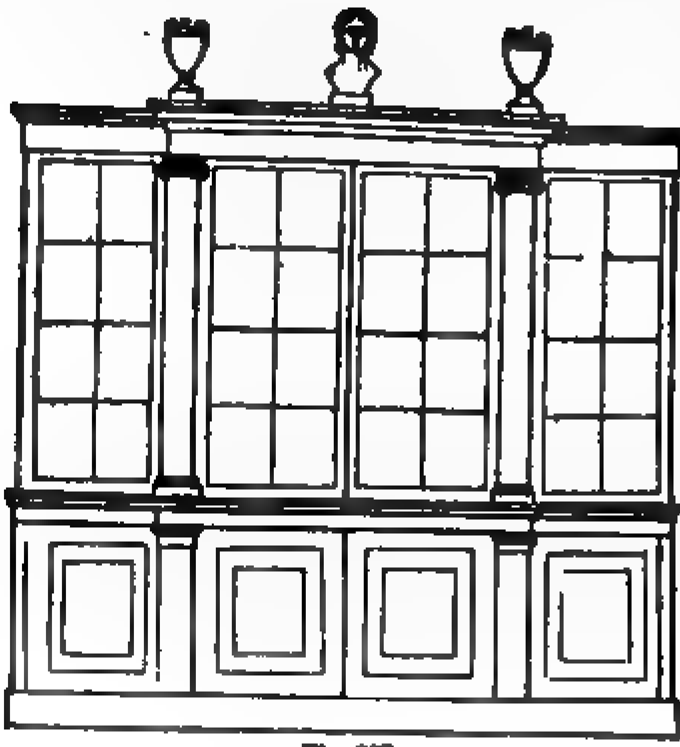


Fig. 327.

Fig. 329.

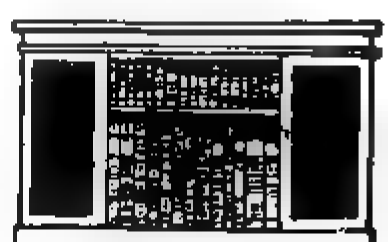
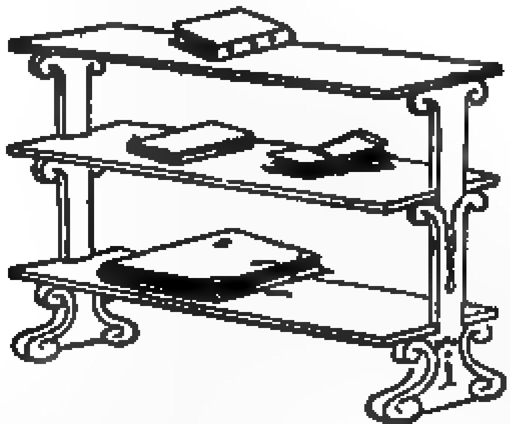


Fig. 328.

Fig. 330.

work, with silk behind, preserves the books, but it has the inconvenience of not allowing us to see the titles without opening the doors. *Fig.* 327 is of the kind called by the upholsterers a winged bookcase. *Fig* 328 is a lower bookcase, termed a *dwarf bookcase*, which is convenient when the room is low, or where it is wished to have all the books easily accessible. *Fig.* 329 is *a small pier bookcase*, to put between windows in the manner of a pier table; or a place for books may form part of a chiffonnière. *Fig.* 330 is one of a similar kind, but with cabinets for minerals, coins, &c., forming a part of it. *Fig.* 331 is *a small bookcase* for a ladies' room. *Figs.* 332 and 333



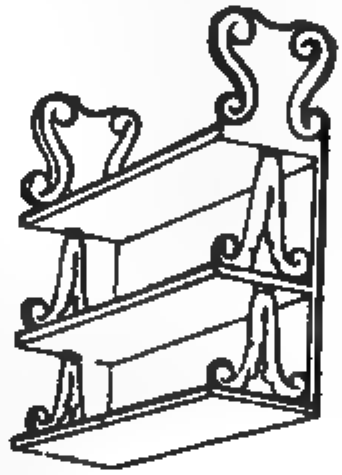


Fig. 331. *Fig.* 332. *Fig.* 333.

are *moveable bookshelves* on casters, very convenient in a library. *Fig* 334 are the *well-known simple bookshelves*, consisting of a few boards and string, which serves well for a nursery, &c.

1141. *Bookstands* are useful articles of furniture, in tending to prevent the injuries which books are liable to receive if laid loose on the tables. They may be made in a great variety of forms and sizes, according to the particular views and wants of individuals. *Fig.* 335 is a

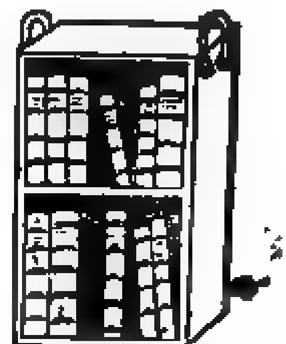


Fig. 334. *Fig.* 335.

very simple bookstand for placing on a table to hold a few books to be referred to. It should not be so large as to be too heavy to be easily lifted by the two handles; or, if made larger, it may be placed upon a stand with castors. *Fig.* 336 is one of more elegant construction, commonly placed upon drawing-room tables. The drawer serves to hold letters, cards, or other papers. *Fig.* 337 is a very convenient kind of bookstand for authors who have occasion to consult a number of books at the same time; the books are placed upon the face of a low conical wheel, and kept open by little brass fasteners, as in music-stands; and, as this wheel may be turned round upon its stand by the least touch, it is easy to refer to the several books without lifting them from their places.

Fig. 336.

Fig. 338.

Fig. 337.

1141. *The reading-desk*, *fig.* 338, is made to place upon a table, and may be raised to any required angle by a frame and rack. Two leaf-holders, of brass, are made to turn upon the edge of the stop lath, for keeping the book open. Another variety is repre-

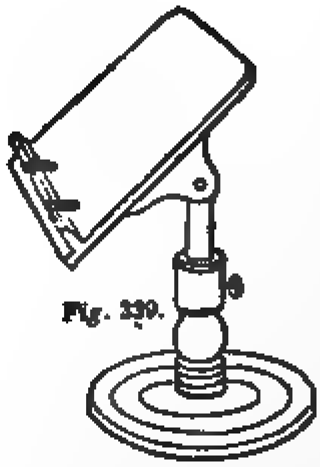


Fig. 339.

sented by *fig*. 339, which may be elevated or lowered, as well as raised to any angle. This is a very convenient invention for the purpose.

1142. *A portfolio stand*, *fig*. 340, is particularly useful where prints or drawings are kept in portfolios: by laying the portfolio flat on a table, frequently the contents receive injury. The flat piece at the bottom of the portfolio is made to fold up when the stand is closed to put away, and there is a contrivance to prevent its opening too far. There are various forms of it; but that in the figure is the simplest.

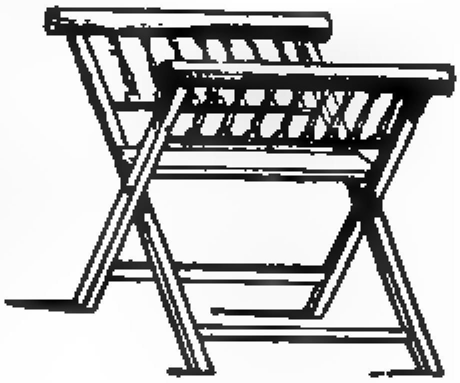


Fig. 340.

1143. *Library steps* are necessary to raise any person so as to reach books at the top of the bookcases. They are sometimes made to close together and imitate some piece of furniture when not in use.

1144. *Writing-tables* and *writing-desks*. The French terms of *bureau*, *escritoires*, and *secrétaires*, are synonymous for these useful pieces of furniture; and our best contrivances of this kind have been originally borrowed from our neighbours. *Fig*. 341 is the well-known bureau, which is now seldom to be found, except at the broker's, but was, not long ago, in very general use, frequently with a neat bookcase over it, and was very convenient, and by no means inelegant, though at present out of fashion. The

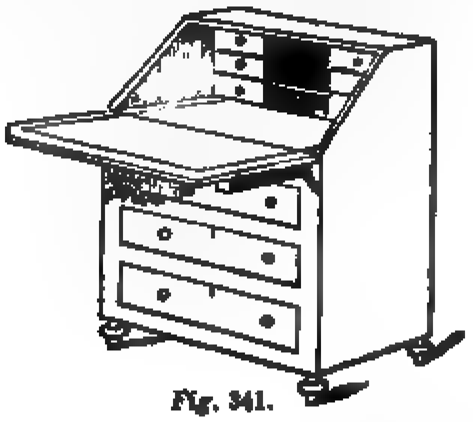


Fig. 341.

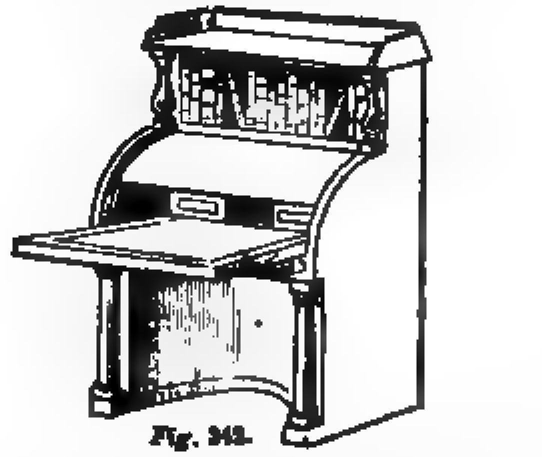
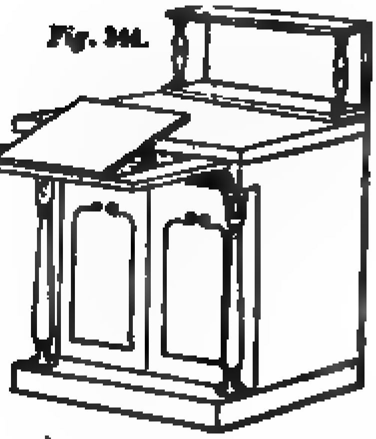


Fig. 342.

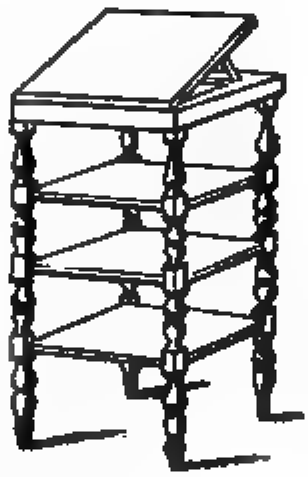
flap for writing upon is made to fall down, and is supported by two runners below that draw out; and within are various small drawers and cells for papers. The large drawers serve as an ordinary chest of drawers. It would seem that the sloping appearance of the flap had been objected to; for we find various contrivances to get rid of this. One is *fig*. 342, in which the small drawers and cells are concealed by a cover made of a number of slips of mahogany, so connected that they draw down in the form of the quarter of a cylinder; and the writing part is made to draw out straight. It may be farther decorated with a place above for books, or for various ornamental things, and the front with columns, consols, &c. *Fig*. 343 is an article of this kind in very general use in France, made to project less into the room; the writing flap goes up perpendicularly, forming part of the front when closed, and is supported by metal quadrants or other contrivances.

Fig. 344 is a writing-table calculated for a ladies' apartment, in which the writing part consists of a shelf that pulls out, having upon it a leaf that lifts up, and may be made to rest upon the table-top, which may be of marble; this will give the necessary slope for writing. The body may contain drawers concealed by folding-doors, or shelves serving as a chiffonnière, or be filled up in any other mode that may be wished for. *Fig*. 345 is a contrivance now much used for writing on, called a *Devonport*, from the name of the inventor. It consists of a desk placed upon a pedestal filled with drawers. The desk is of the same width and depth as the pedestal; but is made to slide forward, when to be written upon, in the manner shown in the wood-cut, to give room for the knees. A sliding shelf may draw out at the side, to hold papers or other things; and over that is an inkstand that turns out and shuts in by a hinge at one end. The desk is covered with leather, and has a fence round the top; the drawers are placed at the end instead of the front, for the convenience of being got at when one is writing.

Fig. 344.



For those who wish to stand while they write, a desk is made, as in *fig*. 346; or in a



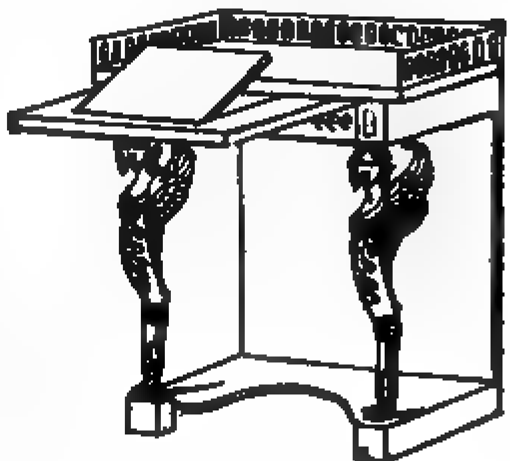


Fig. 348.

Fig. 346.

Fig. 347.

less expensive form, as in *fig*. 347, which is a *what not*, with a rising flap. *Fig*. 348 is a writing-stand for a lady's boudoir.

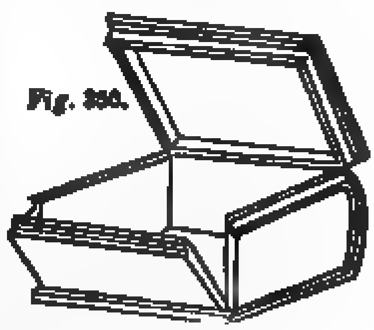
Fig. 349.

The small writing-desks to place on a common table, *fig*. 349, are too well known to need description.

Care should be taken to choose a proper situation for writing-tables or desks, with respect to the light, which should come in from the left.

1145. *The preservation and arrangement of papers* is an affair of great importance, which, when neglected, often occasion great trouble and anxiety, and which might be obviated by a little method.

Fig. 350.



1146. *Rumford* or *pamphlet cases*, *fig* 350, are extremely convenient for holding papers, as they may be placed on shelves like books, and labelled on the back. They are usually procured from the bookbinder, are sometimes made of pasteboard, and bound to look like books; but a cheaper kind, quite as good, is made of thin wood. A cheap substitute may be easily made by small portfolios, with linen or cotton guards to keep out the dust. *Receipts* are best fixed on the leaves of a blank paper book, with a little gum, exactly in the order in which they are received, instead of tying them up in bundles, as they often are, in which it is difficult to find one. The drawers of a library-table afford places for arranging papers, or for keeping them in small portfolios. For this purpose, the fronts of the drawers may be made to let down in the manner of a pianoforte, to get at the papers more easily.

1147. *A small pedestal case*, with shelves or drawers within, *fig*. 351, will be useful, where there is no library-table, for keeping papers in Rumford cases, or in folios. When persons have acquired a taste for arrangement (a very useful one), many similar methods may be contrived, in which facility of reference should form a principal feature. A little money will be judiciously laid out in having proper conveniences for arranging and preserving papers.

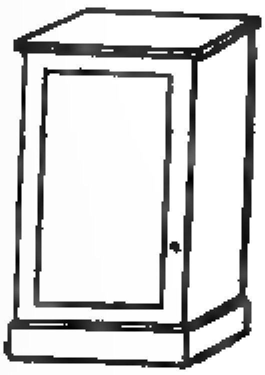


Fig. 351.

1148. *Fire-proof closets and boxes*. The principle upon which these should be constructed is, that they should be made of such materials as are not only incombustible, but as little as possible capable of being heated. Metals are not combustible by ordinary fires; but, as they are susceptible of being made extremely hot, they are not proper for this purpose. If the joints are not perfectly close, so as perfectly

to exclude the external air, papers and other inflammable substances will be burned and consumed in them in case of a fire; and, should the joints be quite tight, papers in them will at least be charred and rendered useless. By referring to our Section "On Heat," the nature of the subject will be understood; and it will be seen that brick, soft stone, layers of pumice, charcoal, and other porous substances, are the best non-conductors of heat. Fire-proof boxes should, therefore, be constructed of these materials, which may be cased with sheet-iron merely to keep them together. Air is, as we have shown, a good non-conductor; therefore, two boxes of non-conducting materials, with an empty space of a few inches between them, will be far safer than any single box. The inner box should rest upon pieces of pumice, and should not touch the external one anywhere; or the space between the two boxes should be filled with pumice. No one unacquainted with these philosophical principles should be intrusted with the construction of a fire-proof closet or box

Sect. X.—Screens.

1149. *Folding screens, fig.* 352, to keep off draughts of cold air, seem to be of Chinese or Japanese origin, if we may judge from the paintings with which they used to be decorated. They are now little used, since the finishing of our houses has been so much improved. Still, there are cases where they are found to add much to comfort, particularly in defending those who are obliged to sit between the door and the fire, where there is always more or less of a current of air. These are to turn the direction of this current, for they can have no effect in destroying it. They have sometimes peculiar hinges, by which they can be folded both ways.

Fig. 352.

1150. *Fire screens* are very necessary where open fires are used, and in England they always form a part of the furniture. In dining-rooms they are particularly wanted for those who sit with their backs to the fire; and various contrivances have been made to prevent the unpleasant effects of this situation. The simplest, and one that frequently answers the purpose, is a flat mat worked of willow, that is hung on the back of each chair requiring such a defence, *fig.* 353.

Fig. 353.

1151. *A cheval fire screen* is one made of mahogany, filled in with moreen and other materials, *fig.* 354, and made to slide up in the stand.

Another variety, *fig.* 355, is made to be increased both in width and height by additional sliding pieces.

1152. *Fire screens for drawing-rooms* are less wanted than formerly, since, from the great improvements in chimney fireplaces, it is not so necessary to sit very near the

Fig. 354.

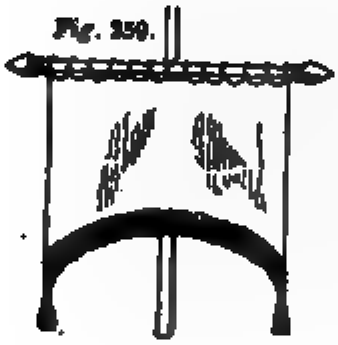


Fig. 359.

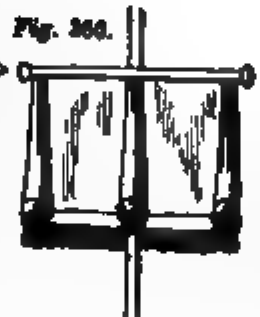


Fig. 360.

Fig. 356.

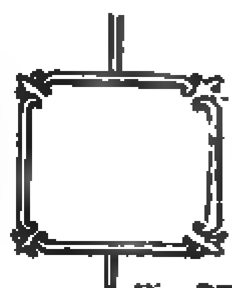


Fig. 357.

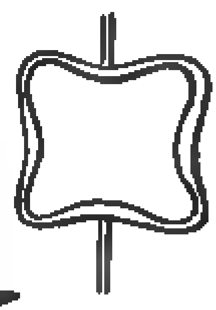


Fig. 358.

fire. When they are employed, they are made light and elegant, and are generally only large enough to screen the face. *Figs.* 356, 357, 358 are examples of forms in com-

mon use, which may be of mahogany, the screen covered with silk, paintings, &c. *Figs.* 359, 360 are very simple screens made by suspending a piece of silk on a brass or wooden rod. It is requisite that the base of all fire screens should be strong and solid, as well as somewhat heavy, that they may not easily overset.

1153. *That a pane of glass should form a fire screen is a remarkable fact.* It appears that, although the heating rays, as well as the light of the sun, can readily pass through glass, as is evident from green-houses and ordinary windows, yet the calorific rays from the fire are almost entirely stopped by glass. On this principle, a piece of window or plate glass can form a fire screen by enclosing it in a frame; and this is both agreeable and convenient, since the fire may be seen through it. The only inconvenience is its liability to be broken.

Sect. XI.—SCULPTURE, PAINTINGS, ETC.

1154. There are few houses where some other objects are not collected to decorate the apartments besides the mere furniture. Pictures, statues, bas-reliefs, vases, porcelain, minerals, flowers, even toys of various kinds, are introduced; and their selection distinguishes, in some measure, the taste and judgment of the possessors. The desire for being surrounded by objects of interest is both natural and useful, provided it be kept within due bounds. It has been remarked that uncivilized nations, and almost the poorest among civilized people, have more or less of this taste for decoration; and to it we owe many of the most valuable arts. When the inhabitant of the humble cottage in any country is seen to adorn his dwelling with works of art, even of the lowest kind, we may be sure that he possesses the germes of some good feeling capable of being cultivated. While the wealthy procure genuine pictures and sculpture of the best kind, those in middling circumstances may easily obtain works of great merit at a much smaller expense.

1155. *When sculpture, instead of being insulated, is attached to a surface*, it is termed *alto-relievo*, and *basso-relievo*; or alto-relief, and bas-relief. The first is, when the figures project from the wall at least half their thickness; and when the projection is less, it is bas-relief. This kind of sculpture is frequently employed in friezes, chimney pieces, and other parts near to the eye; but it seldom has a good effect, or is lost and thrown away when placed too high, as may be seen in several of our public buildings erected by architects of reputation. A considerable objection to the use of much sculpture in the decoration of rooms is the dust which it collects, and which cannot be frequently cleared away without injuring the carving. Painting, on this account, has some advantages over reliefs. The ancients have left us many exquisite specimens of bas-reliefs, both in marble and terra cotta; and many of great merit have also been executed by modern sculptors.

1156. *Plaster casts of fine sculpture* are scarcely inferior, in some of the most valuable qualities, to the original marble, and may be rendered durable by easy processes: they may be hardened, painted, varnished, or bronzed.

1157. *Much modern sculpture in alabaster is brought* from Florence, consisting chiefly of small figures and vases, which must be kept under glass; but the greater part of it is of very ordinary, if not inferior workmanship, and is chiefly striking for the beauty of the material, or the elaborate pierced carving. Abundance of small figures in terra cotta, or other materials, are produced by some of our own sculptors too little known; some of these have infinitely more merit as works of art, and deserve places in our best apartments.

1158. *Carvings in ivory* are often extremely valuable, and require particular care to preserve them. When exposed to the air unprotected, and kept from the sun, they become discoloured, and covered with a multitude of minute cracks; but if they are kept under glass they are not liable to this change. The cracks cannot easily be remedied; but when they have occurred, the ivory should be brushed with warm water and soap, to get out the dust that may have insinuated itself into the cracks. Exposing the ivory to the sun's rays for some time under glass will bleach them in some degree; but this may be done effectually by a cautious use of chlorine.

1159. *Ornamental vases.* As these are very frequently employed to decorate apartments, it is proper that some attention should be paid to the style of those which are selected for this purpose, since this is frequently thought to afford some indication of the possessor's taste. In no circumstance is the superiority of some of the ancient nations, particularly the Greeks, more strikingly exhibited than in the beautiful and varied forms of their vases; and although the moderns have carried some branches of the fine arts to a high degree of perfection, yet they have failed in inventing designs for vases which can bear a comparison with the antique. The germes of this fine taste are discoverable in the Egyptian and Etruscan vases, which were copied and improved upon by the Greeks, who have left us the most splendid and perfect specimens

Athens, at one time, took the lead in the manufacture of earthenware vases; but the potteries of Samos soon rose into great repute, and, with those of Saguntum in Spain, and one or two towns in Italy, furnished the chief supply. They were formed

of the purest clay, and were distinguished by their extreme lightness. To render them impervious, instead of a glaze they were covered with a varnish of bitumen, which admitted of a fine polish, and was, besides, very durable.

1160. *Fine examples of Egyptian and Etruscan vases*, made of earthenware, may be seen in the British Museum, of which *figs*. 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, are copies. *Fig*. 365 is a large Etruscar vase richly painted with black figures on the red ground peculiar to that ware.

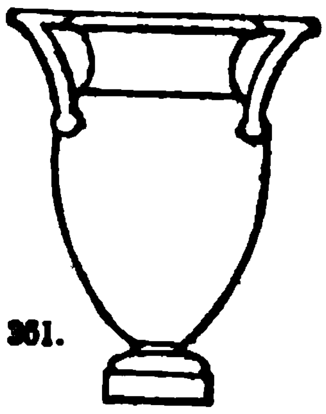


Fig. 361.

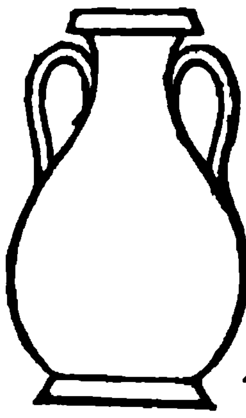


Fig. 362.

Fig. 363.

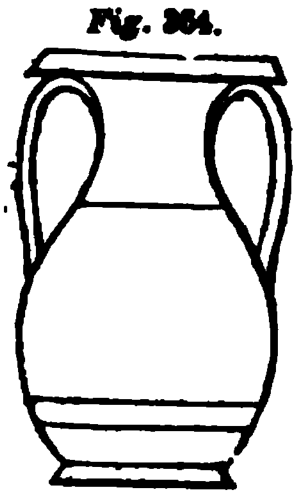
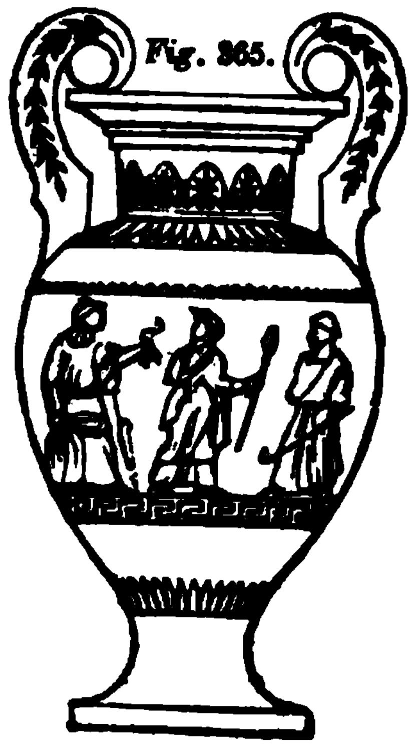

Fig. 364.


Fig. 365.


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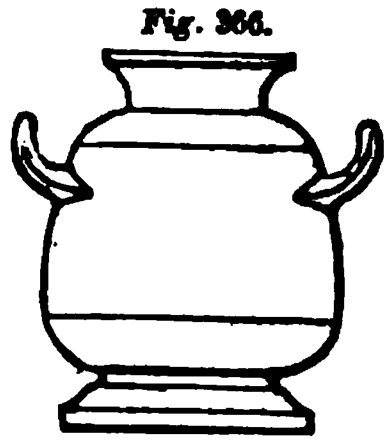
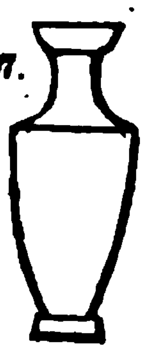


Fig. 367.


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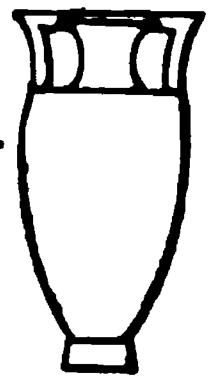

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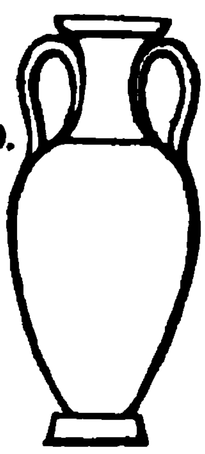


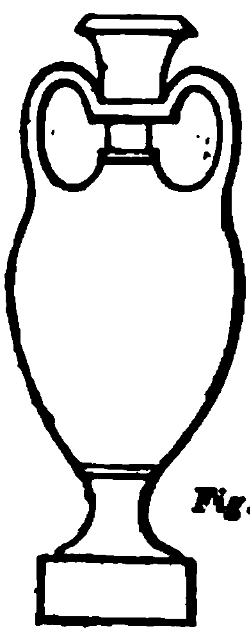


Fig. 370.

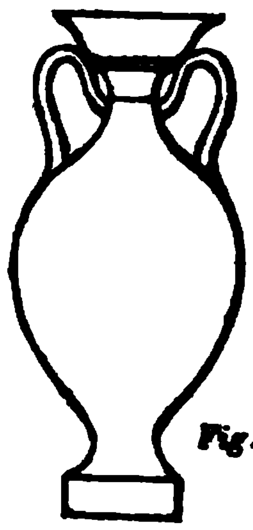


Fig. 371.

1161. *Figs*. 372, 373, 374, 375, 376, 377, 378, 379, 380, *are Greek vases of marble*.

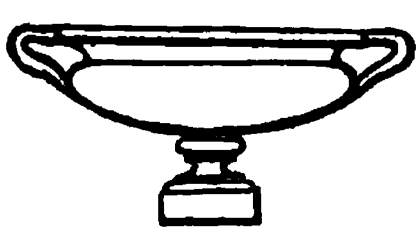


Fig. 372.

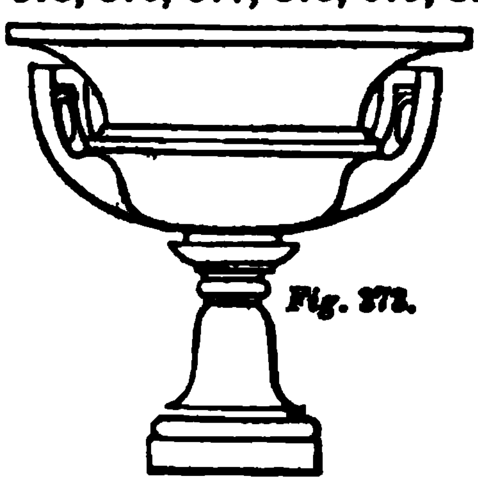


Fig. 373.

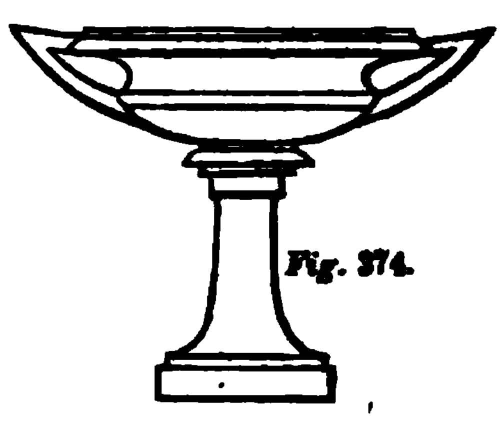


Fig. 374.

1162. *Large jars of Chinese porcelain* are often placed as ornaments, but these are interesting more on account of their being curious specimens of a manufacture than from the taste displayed in them. The Florentine alabaster vases have been already alluded to, when speaking of sculpture.

Fig. 375.

Fig. 376.

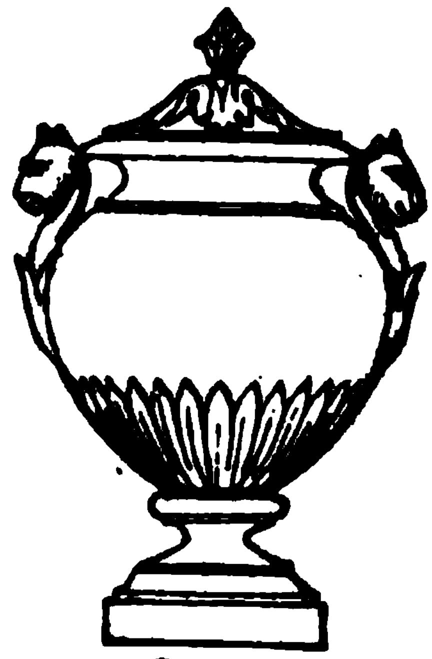


Fig. 377.

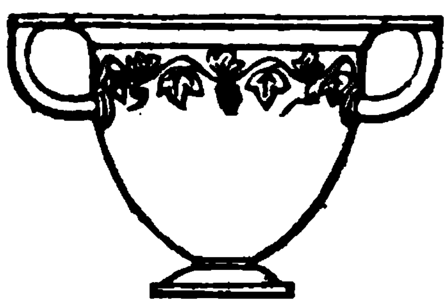


Fig. 378.

Fig. 379.

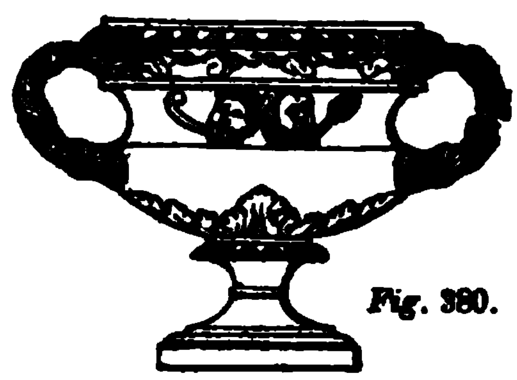


Fig. 380.

1163. *Vases of fluor spar* from Derbyshire are extremely beautiful. M. de Rozière wrote, some years ago, an interesting work to prove that it was of this substance the famous *Murrhine* vases of the ancients, so highly prized, were made; and there really appears much weight in his arguments, this substance agreeing with the ancient description more nearly than any other known material.

1164. *Paintings and drawings* form some of the most desirable ornaments of our apartments on many accounts. Oil pictures demand gilt frames; drawings do very well in frames of various elegant woods. The hanging of pictures properly requires judgment, and much depends upon the direction of the light that comes on them. A side light is the best, and the worst is fronting a window, as the gloss of the varnish forms a sort of mirror, in consequence of which they cannot be seen except the spectator stands on one side. It is mortifying to see a good picture hung in a bad light, and a bad picture had better not be hung up at all. But certain drawings are not so much injured by the effect of light, and may be placed where an oil picture would be lost.

1165. *Since it is almost impossible to find good situations* for many pictures in a moderately-sized house, the best mode is to place them in a gallery built on purpose, if they are numerous, and there justice may be done to them all. The modes of warming by steam or hot water render such an apartment agreeable on a visit paid to it in the coldest weather.

1166. *Artificial flowers* are beautiful ornaments; and are useful, since the natural ones cannot be had at all times and in all seasons; those of wax, in particular, so closely resemble real flowers, that the imitation seems quite perfect, and they well deserve patronage.

1167. *Many of these objects which are classed as curiosities* may be considered as furniture, since they are frequently employed in the decoration of apartments; the taste for collecting them has been often ridiculed, but it is not deservedly so, except when little judgment is employed, or when carried to excess.

1168. *Engravings* are little used at present as ornaments in rooms, though they were some years ago. Many, however, well deserve this distinction, although in general the effect of many engravings hung on walls is much inferior to that of pictures and drawings.

1169. *Minerals and other objects of natural history* form admirable ornaments for rooms; but they should be kept under glass, otherwise they soon spoil by the dust and smoke, and cannot be restored to their original beauty. A small cabinet, with glass doors, would be an agreeable and entertaining acquisition in almost any apartment. We frequently see in drawing-rooms elegant little tables covered with common and useless toys in porcelain, or figures ill painted on cards, for which more money has been given to the fancy shops than would have purchased works of art of great beauty and merit; while some, again, throw away money upon bad copies of old pictures that

have been recently brought from the garret of the painter, after he has employed his talents in smoking and cracking them, that they may the better imitate the originals.

SECT. XII.—TAPESTRY, EMBROIDERY, AND FILIGREE.

1170. *Tapestry was much employed in ancient times* for covering the walls of apartments in magnificent houses. The term is derived from the Latin *tapes*, the cover of a wall or bed, from whence also comes the French *tapisser*, to line; and it has sometimes been applied as a general name for all kinds of hangings, whether woven or wrought with the needle, and whether silken, woollen, linen, leather, or paper; but it is now appropriated to a kind of woven hangings of wool and silk, adorned with scenic representations in imitation of paintings.

1171. *The earliest embroidery and tapestry were the work of the needle;* and we find in the Scriptures mention of rich dresses and various articles of furniture ornamented in this way with coloured silks, worsted, and gold thread. The Medes, Persians, and Babylonians were celebrated for their tapestry and embroidery; and the Egyptian women particularly excelled in this work, from whom the Israelites derived the knowledge of it. These arts were a favourite occupation of the Grecian ladies, and the labours of Penelope have become proverbial. Robes ornamented by embroidery were general among the Greeks and Romans, and this fashion has come down to modern times.

Some considerable works in tapestry, worked by the needle, had been executed in Germany, France, and England soon after the third century, particularly for Catholic churches and convents, and often by ladies of the highest rank. The most remarkable of these now existing is the Bayeux tapestry, the work of Matilda, wife of William the Norman conqueror. This magnificent example of ancient female industry is 227 feet long and 20 inches wide; it contains 530 figures, representing the various scenes of the Norman invasion, and is kept in the town-hall of Rouen as a precious relic. It is worked in different-coloured worsteds, on cloth originally white, but now become brown; the colours are preserved tolerably bright. The drawing of the figures is, as might be expected from the state of the arts when it was executed, stiff and rude, but the costumes of the time having been carefully attended to, the whole is very illustrative.

1172. *It appears that in Chaucer's time tapestry was much used in England* for decorating the walls of apartments belonging to wealthy persons, but it was worked in gaudy colours, and hence was more useful than elegant, contributing much, however, to comfort in houses where the bad finishing admitted innumerable draughts of air; but the best tapestries were only put up when the rooms were inhabited; a few of these tapestries still remain in ancient mansions. When the walls of rooms were furnished with moveable hangings, other materials, as leather, flowered and gilded in various patterns, and silk, were frequently employed.

1173. *It is not known exactly at what period the weaving of tapestry by the loom was first* practised; but the art appears to have passed from the East into Europe. Some suppose that this rich manufacture was brought from the Levant by the crusaders, and it became at length the greatest ornament of palaces, churches, and other public buildings. The French ascribe the invention to the Saracens; and hence the workmen employed in it were called Sarazins. Guicciardini states it to belong to the Dutch. The first manufactories of tapestry, of any note, were those of Flanders, established there long before they were attempted in France or England. The chief of these were at Brussels, Antwerp, Oudenarde, Lisle, Tournay, Bruges, and Valenciennes. At Brussels and Antwerp they succeeded well, both in the design and the execution of human figures and animals, and also in landscapes. At Oudenarde landscapes were better imitated, but they did not succeed so well with the figure. The other manufactories, always excepting those of Arras, were inferior to these. The manufactories of Arras, indeed, were so celebrated, that the name of this place has been frequently given to tapestry. Sully, the minister of Henry IV. of France, devoted his attention to this manufacture, and was enabled, by means of Flemish artists, to establish that of the Gobelins near Paris, which, under Louis XIV., became so celebrated as to be considered the first in the world. The name of Gobelins was taken from that of two excellent dyers, because the manufacture was first carried on in a house which had been built by them. In this place the most able artists, among others Le Brun, were employed to make designs, and to direct copies of the best pictures. When the tapestries were large they were woven in parts, which were united by the *rentrayeurs*, or fine drawers; and many of these productions are scarcely inferior to the paintings they were copied from. This art is generally supposed to have been brought into England by William Sheldon, about the end of the reign of Henry VIII., and parts of some maps in tapestry, made by Hicks, the artist he employed, were lately preserved at Strawberry Hill.

1174. *In 1619 a considerable manufacture was established at Mortlake*, in Surrey, by Sir Francis Crane, who received £2000 from King James to assist in carrying it on; and,

according to Walpole, it was brought to great perfection. At his establishment some superb tapestries were executed during the reign of Charles I., from designs of distinguished painters, such as Rubens and Vandyke, several of which still exist, as at Hampton Court Palace, and Mary's Hall, Coventry. During the civil wars the manufacture languished, and under the Commonwealth it was abolished; nor has there been any manufacture of tapestry in this country since that time.

1175. *In the time of Queen Elizabeth, tapestry, called arras-work,* was very generally adopted in the houses of the country gentry, but this was of a course fabric, partly the produce of the loom, but also of the needle, and sometimes, it would appear, little more than painted cloths; and it was suspended on frames, which were at a little distance from the walls, and thus afforded the means of persons concealing themselves behind them. A superb set of pictures in tapestry, representing the destruction of the Spanish armada, was executed in Flanders, and long ornamented our House of Lords, until they were destroyed in the fire of 1834. Fortunately, a set of engravings had been made from them by John Pine, in 1739, and a fragment of one of them still exists in Plymouth.

1176. *The use of plaster of Paris in finishing the walls of apartments,* which began to be general in the reign of Queen Elizabeth, caused that of tapestries to be discontinued, from the facility with which architectural ornaments in relief could be produced; and tapestry is at present seldom seen except in restorations or imitations of ancient mansions. In France it is still executed at some of the great manufactories; and in that country there are preserved abundant examples of ancient tapestry.

1177. *Embroidery* is much more generally used abroad than with us for ornamenting dress. Threads of the brightest and most showy kinds are employed.

Embroidered handkerchiefs, generally carried in the hand, are universally used in Turkey, and the neighbouring nations of Asia, and are often bestowed as presents by Turkish ladies, by whom the working of them is a favourite amusement. Embroidery is also much practised at present by ladies in Germany; with this they ornament various articles of furniture, as screens, ottomans, footstools, &c. This practice has lately been fashionable among ladies in England, and German patterns, as well as all the various materials, canvass, wools, and silks, are now sold in many of the London shops.

Muslin was formerly embroidered by stretching it on an instrument called a *tambour;* the more open the muslin, the better it is adapted for the purpose; but it is now more generally worked in the hand. A great many hands were employed in embroidering muslins; and this work was chiefly carried on in the south of Scotland and north of England. Embroidery is one of the last things that one would expect to see done by machinery; yet this has been effected by M. Heilman, of Mulhausen. His invention was exhibited in Paris in 1834, and several of his machines, by which about 130 needles are worked by one grown-up person and two children, are employed in France, Germany, and Switzerland. Lately they have been introduced at Manchester. One machine, capable of doing the work of fifteen expert embroiderers, cost about £200. The machine copies the pattern by a pentagraph.

1178. *Filagree* is an ornamental work composed of threads of gold, silver, paper, or other substance, wrought together in a curious and ingenious manner. Our term comes from the Italian *filigrana,* threads and beads, because the latter were originally mixed with it. The art is of great antiquity, having been brought from Egypt and the East; and was formerly much employed in church furniture, as for decorating vases, images of saints, &c. Beautiful articles of this kind are manufactured in the Deccan, and among the Turks and Armenians. Mr. Marsden informs us that the Malays excel in this art. The best filagree is executed with threads of gold or silver, and gilt or coloured paper is also used. Making filagree was, at one time, a fashionable employment, but is now nearly obsolete.

CHAPTER XI.

FURNITURE OF THE ENTRANCE HALL.

1179. *Hall chairs, figs.* 381, 382, 383, are made in a particular style, and are always either wholly of mahogany or wainscot: they have more or less of turned or carved ornaments, and have sometimes heraldic shields or the crests of the owners. *Figs.* 384, 385 are *hall seats.* (See next page.)

1180. *Hat and cloak pins, and umbrella-stands.* It is usual to have proper places for hanging up hats, cloaks, greatcoats, and umbrellas: these should be not far from the entrance, easily accessible, yet safe. When there is little room, they are generally hung on pins fixed in a wooden rail against the wall; but, where there is space enough, stands for the purpose are better, as garments dry sooner on these.

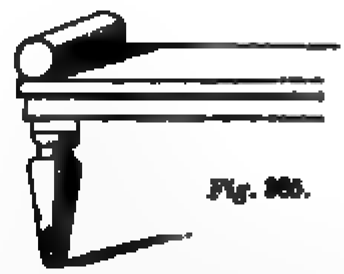
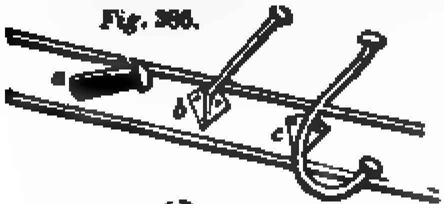


Fig. 385.

Fig. 386, *a*, represents pins made of wood, turned and let perpendicularly into a mahogany rail fixed to the wall at a proper height. Cloak pins, *fig* 386, *b* and *c*, are likewise made of brass and of cast iron, and are screwed on to the rail, their direction pointing upward, the better to secure what is hung on them; another kind has the lower part of it turned upward to hang the hat on. Cloak and umbrella stands are sometimes made of mahogany, consisting of a stem and cross bars, as in *fig*. 387; the lowest rail has large knobs for the umbrellas to stand between, draining into the box, which has a loose japanned tin tray within. The cloaks are hung upon the three upper rails. *Fig*. 388 is a cloak and umbrella stand made of cast iron. *Fig*. 389 is an umbrella-stand made of tin painted; and *fig*. 390 is one that may be constructed of wood.

Fig. 386.



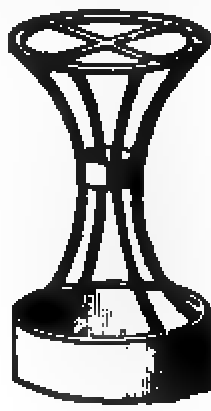


Fig. 389.

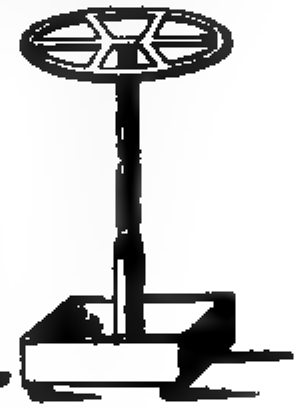


Fig. 390.

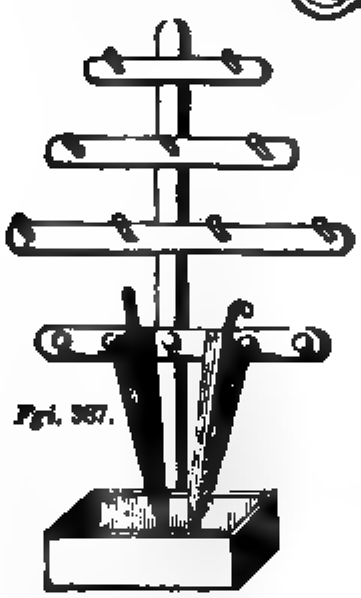


Fig. 387.

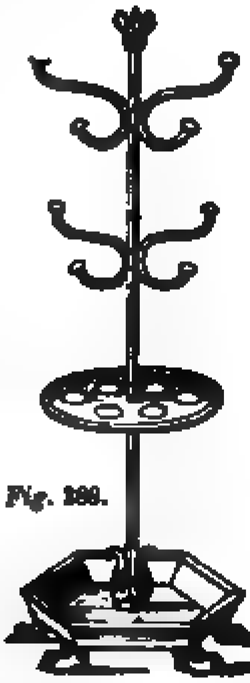


Fig. 388.

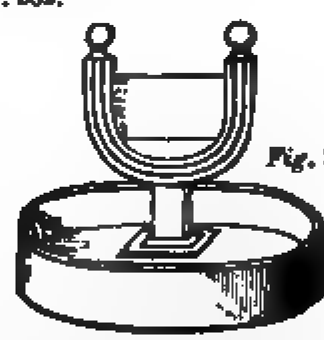


Fig. 391.

1161. *Door-scrapers* for the feet are placed at the entrance of every house, and should be in such a situation as to be easily seen. The variety of form is endless, from a simple piece of iron hoop fixed across two uprights of any kind, to those of cast iron, ornamented in various ways, and kept by the ironmongers. They should always, if possible, have a receptacle for the dirt to fall into. A portable scraper, *fig*. 391, which costs only two shillings, is useful, because it may be placed in any situation; as, for instance, in any part of the garden.

CHAPTER XII.

BEDROOM FURNITURE.

1182. The furniture of bedrooms, being of a particular kind, it appears proper to treat of it as a class distinct from that of the principal apartments.

SECT. I.—BEDS.

1183. *The subject of beds* includes the description of bedsteads, the bed itself, bed furniture, and bedding.

Bedsteads are the solid constructions or frame work upon which the bed itself rests, together with the canopy over it. Bed furniture comprises the curtains which generally enclose the bed, or which are suspended from the canopy or top. Bedding includes beds and mattresses of all kinds, whatever they may be stuffed with; also the bolster, pillows, sheets, blankets, and counterpane.

1184. *Historical remarks.*—In the first and ruder ages of mankind, it was the general practice to sleep upon the skins of beasts, as was the case with the ancient Britons, and this custom still prevails in many of the Asiatic countries, and other parts of the world. These skins, some of which were worn in the day, were spread at night on the floors of their apartments In process of time, these skins were changed for beds stuffed with straw, chaff, cotton, or other soft materials.

Bedsteads among the Greeks were of the most simple forms, consisting of a couch without any curtains: they may be often seen represented on antique bas-reliefs and in paintings, and appear to have had girth bottoms. We read also of pensile or suspended beds, by which, if necessary, the person might be rocked to sleep; these appear to have resembled our hammocks or cot beds.

Among the ancient Romans, a species of bed was used unknown in modern times, which was for the purpose of resting upon at meals: this kind of bed was called *Triclinium*, from its being usually occupied by three persons. These, in the luxurious times of the emperors, were of the most surprising magnificence; and we are informed by Pliny that they were frequently formed of ivory, adorned with plates of silver and gold, and covered by the softest mats and counterpanes. The use of feathers for beds is not modern, for Pliny informs us that they were in use among the Roman gentry, and at the inns beds were filled with the soft leaves of reeds.

In the houses of the wealthy, and even in the royal chambers of England, beds stuffed with straw or chaff were used so late as the close of the thirteenth century; the bed furniture was of a very costly description, and made of such durable materials as to last for many years; a few have descended down even to the present times, and are preserved in old manor houses. The hangings were sometimes of silk damask, or of velvet, and embroidered with coloured silk, or of rich stuffs. The testers were generally low, the necessity for plenty of air not having been then understood: the valances were generally plain, but scolloped with various forms at their lower edges. Some were surmounted with feathers. The effect of the whole was heavy, but calculated to have an air of gloomy grandeur suited to the times. Their great expense prevented their frequent removal, and the nature of the materials collected dust, and rendered it difficult to clean them so often, or so effectually, as might be desirable. Our modern light furniture is much preferable, and with care may last sufficiently.

Among the Eastern nations, beds are seldom raised from the ground. In the evening, mattresses stuffed with cotton, of which they keep a considerable number in great houses, are brought into the room, and laid down on the floor: often they have no other beds than the divan used in the day. The poorer people lie only on mats spread on the ground.

1185. German beds differ remarkably from our mode in England. They make the upper part so high by means of many pillows placed underneath, that they rather sit than lie in bed; some do not use blankets, but, instead of them, have a wadded counterpane over the sheets; and, in winter, a light feather bed, sometimes of down, is added as a *couvre-pieds*. This custom, though sometimes spoken of with ridicule, is said to be extremely comfortable in very cold countries.

1186. In England and Scotland, during the feudal period of our history, the proprietors of land lived in castles, which were not always accommodated with a number of rooms; and, when it was necessary for the greater number of the inhabitants to sleep together in the great hall, straw was brought in for that purpose, and was swept away next morning. From the following account given by Hollingshed, we may judge of the mode of sleeping in England at a later period. "Our fathers, and we ourselves, have lain full often upon straw pallettes, covered only with a sheet under coverlets made of dogswain or hoperlots (I use their own terms), and a good round log under their head instead of a bolster. If it were so, that the father or the good man of the house had a mattress or a flock bed, and thereto a sack of chaff to rest his head upon, he thought himself to be as well lodged as the lord of the town. So well were they contented.

Pillows (said they) were thought meet only for women in childbed. As for servants, if they had any sheet above them, it was well: for seldom they had any under their bodies, to keep them from the prickling straws, that ran oft through the canvass, and razed their hardened hides."

1187. *General Observations on Beds.*—In the present day, when the study of physiology, and the importance of pure air, and great cleanliness are beginning to be understood, everything relating to our places of repose during the night receives particular attention from persons of intelligence; and yet much of this knowledge, so important to our health, is not sufficiently diffused. In treating on ventilation, we pointed out the necessity there was for breathing good and wholesome air; a necessity which exists in the strongest degree during the night, when we do not change our situation for many hours together. It can scarcely be necessary to repeat how pernicious to health are very small bedrooms, from the vitiation of the air by constant breathing; but the same reasons will apply to all circumstances which prevent the change of the air round about us when in bed, and which compel us to breathe over again a portion of that air which we have expired. This principle being kept in view, and thoroughly understood, it will be easy to comprehend in what manner this part of our domicil must be treated. In small bedrooms it is best to do without curtains, or at least to have them only partial, and not enclose the bed. When curtains are drawn close round a bed, it is, in fact, nearly equal to sleeping in a small room. It has been for some time the fashion to raise beds high above the floor, but in low apartments it is particularly improper to do so, since this lessens the distance from the ceiling, and keeps the person immersed in a bad atmosphere, since the expired air rises to the top of the room. In low chambers, therefore, the beds should be as near the floor as possible; but where the apartments are lofty, there is no occasion for this, and keeping the bed at a moderate height has the convenience of admitting sweeping under it. The corner of a room is a bad situation for a bed, as it cannot be got round without moving it. It should be placed, if possible, nearly at the middle of the side, but should not quite touch the wall.

Physicians remark that soft feather beds, in which the body sinks so deep as to be almost surrounded by feathers, have a relaxing effect, occasioning an undue warmth that weakens the action of the skin, and renders the individual very susceptible of cold when exposed out of doors. They recommend that, when a feather bed is used, it should be so well stuffed as to afford ample resistance to the weight of the body. On this account, many persons prefer sleeping upon mattresses only, particularly in summer. These observations, however, apply chiefly to the young and vigorous, who may sleep sound upon a hard bed; but the aged and infirm, except the bed be moderately soft, would thus pass many a sleepless night. The covering should be light. For very cold weather some have the counterpane quilted with cotton wool; eider down is better. For comfort and cleanliness, the more simple the style of the hangings the better Much drapery confines the air, harbours dust, and is not only expensive, but requires a great deal of trouble to keep it as clean as is necessary. Dr. Franklin recommended as an improvement, to those who can afford so great a luxury, to have two beds near each other; and if one wakes, feeling the bed too hot, to go into the cool one. A large bed, admitting a removal to another portion, in some degree answers this purpose.

Health demands that all the materials of beds should be kept as clean as possible. Beds or mattresses, when impregnated with animal effluvia from the human body, and particularly in cases of sickness, are improper to sleep upon. They ought, therefore, to be frequently well aired, and likewise occasionally taken to pieces, and the materials beat, carded, washed, or otherwise cleaned. Blankets retain animal effluvia with considerable pertinacity, and ought always to be scoured after considerable sickness.

1188. *Four-post bedsteads*, as they are called, are the sort most generally used in England for the best beds. These consist of four lofty pillars, with a bed frame, and canopy with curtains. *Fig.* 392 represents a bedstead of this kind without curtains or bedding. Of

the four bedposts, the two at the head are usually plain and square, because they are, in a great measure, concealed by the curtains; the other two at the foot of the bed are always more or less ornamented with turned mouldings or carving. These are generally of mahogany, but occasionally of other fine wood, as satinwood; and some have lately been made extremely elegant of porcelain. As they are made of solid wood, the thickness increases the expense considerably. The *bed-frame* is fixed to the four posts by strong screws, which must be unscrewed when the bed is taken to pieces; and a particular implement, called a bed-screw, is kept for that purpose. Sacking sometimes, but in the best beds laths, are put across to lay the bedding upon. The *head-board* is fixed across, and drops into grooves in the square posts at the head; and sometimes there is likewise a *foot-board* fixed in a similar manner to protect the feet. There is a *cornice* at the top of the bedstead, which is best made of mahogany, French polished, or wood japanned, which is cheaper, though not so durable. Cornices are at present made extremely plain, as much carving is found to harbour dust, independently of the expense. The architrave is sometimes omitted. The *tester lath* is the square lath fixed on the top of the posts, to which the valance is nailed, and to carry the curtain rods.

1169. *The drapery of beds or bed furniture* includes the curtains, valance, and head-cloth. *Bed-curtains* are made of various materials, as silk, damask, moreen, chints, or dimity. Silk is, of course, the richest, but by far the most expensive, and is seldom used. Moreen, and other woollen stuffs, were much employed some time ago, partly from their rich appearance, and partly because they were thought warmer; but at present they are not so much employed, being liable to moths, and to collect dust. Chints is generally preferred, being more easily washed; and curtains of it are usually lined with a thin glazed cotton, generally dyed plain. Dimity has the advantage, being cheap, and admitting of being washed frequently. It must be observed, however, that both chints and dimity are more easily set on fire than woollen stuffs. It is said that the liability to take fire can be prevented in dimity curtains if they are dipped in a solution of alum after they are washed. *Fig.* 393 represents the bed completely fitted up. The *valance* is a piece of drapery fixed to the tester lath to hide the curtain rods. The *head cloth* is stretched from pillar to pillar at the head of the bed, and is generally ornamented by being plaited in some elegant mode.

Fig. 393.

It was the fashion formerly to ornament the bed furniture with festooned and fringed valances, with highly-enriched cornices and tassels; but these were found to collect dust, and to occasion much trouble, in addition to useless expense. At present it is the fashion to contrive all the parts of a bed in a very simple manner, so as to be easily taken to pieces to clean. The valance, indeed, is now frequently put inside the curtain rods, which, instead of being concealed, are made ornamental. One advantage in having the curtain rods outside is, that the dust which collects about the rings can be swept off without soiling the bed. Sometimes, however, for economy, and particularly for summer, plaited valances may be contrived of muslin or other materials, to serve instead of cornices and other upholsterer's work, and may be ornamented with lace, riband, &c.; but this is mentioned as a temporary mode merely, or where the family can itself manage these matters. The *curtain rods* were formerly made of iron: brass is now generally used; and if they are outside, they are made of metal, and of large diameter; but they are often made of wood, if they are inside, which makes less noise when the curtains are moved. The *curtain rings* have each an eye, *fig.* 394, below the ring, into which is put the end of a small hook sewed to the inside of the upper edge of the curtain; by unhooking these, the curtains can be taken down when required. When the rods are outside the valance, they are fixed to square blocks on the top of the bedposts, or to brass brackets at the angles. The whole stands upon *castors* under each post or pillar. These are always of wood, and that the bed may be easily moved, are made large. The kind called French castors, *fig.* 395, are much better than the common ones, which are apt

Fig. 394.

Fig. 395.

to come off and be out of order. Instead of being fixed to the posts themselves, they are fixed to an angle piece, by which they are made secure, and are out of sight. *Double screwed beds* are those in which each rail of the frame has two screws to fix it to the pillars, which is stronger than when there is only one screw.

1190. *Figs.* 396 and 397 are cornices with valances in the taste at present much in fashion, where the rods are to be concealed.

Fig. 396.

Fig. 397.

1191. *Fig.* 398 is an example of a four-post bedstead in the Elizabethan style. The whole is of oak, ceiling and head included, which are panelled and enriched with carving. The curtains are omitted to show the design better.

Fig. 398.

1192. *French beds* are remarkable for their variety of forms, and the taste which they admit of displaying. The *cottage French* pole-bed, *fig.* 399, is of very simple construction, and is now much used in this country as an economical piece of furniture. One of its great conveniences is the manner in which the curtain is contrived. This consists merely of a piece of drapery thrown over a pole which is generally fixed to the wall at the place where the bed is to stand; it can be taken down with the utmost facility, and the usual expense of making up attending other curtains is here saved. In places where the pole cannot be conveniently fixed to the wall, it may be attached to an upright piece forming part of the bed, as in the woodcut. *Fig.* 400 shows the bed, with the furniture and bedding complete. Some object to the curtain reaching so low at the head; in consequence of which one cannot well sit upright in bed, and the air is too much confined near

the face. This inconvenience may be removed by hanging the curtains as in *fig.* 401, though by the sacrifice of some uniformity. Many persons use them without curtains, and in small rooms they are better without, particularly for young people. Their being easily moved and taken to pieces is one of their principal advantages. The curtains are certainly more elegant than those of the tent bed, *fig.* 405, and less apt to collect dust; but they are not so convenient as those of tent beds may be, if hung with rings upon a rod at the top of the upright posts in *fig.* 406, which will open by drawing aside. They are usually painted in imitation of some expensive wood.

1193. More elegant French beds are made of mahogany, somewhat in the form of a sofa or couch, and have canopies and draperies of a more fanciful kind, ornamented in various ways, as *figs.* 402, 403.

Fig. 401.

Fig. 404 is one upon a classical model.

1194. *Tent beds, figs.* 405 and 406, are in very general use in England. Four upright posts are placed at the corners of the bed-frame, with its sacking or laths; and on the bedposts rest the tester laths, which drop on iron pins on the top, that are covered by wooden knobs. The posts at the foot of the bed are turned and ornamented in some way, but those at the head are made square and plain, as they are always covered by the curtains; into a groove in them the head board is inserted. The curtains to throw over the whole are usually made of chintz; they are fastened up in the day by cords, and not drawn on rods.

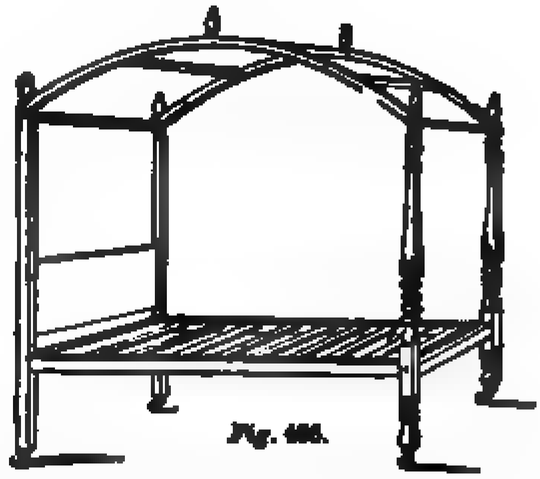


Fig. 405.

Fig. 406.

1195. *Half tester bedsteads* are another variety of beds to turn up during the day to gain room. The bedstead, *fig.* 407, when turned up, is enclosed within curtains drawn round it, and which are hung to a small tester, from which the name. They are not quite so shut up from the air as the press bedstead, but they have always the appearance of a bed. The valance may, however, be made more ornamental by festoons, fringe, or scollops. *Fig.* 408 is another turn-up bed to appear as a narrow tent bed when put up.

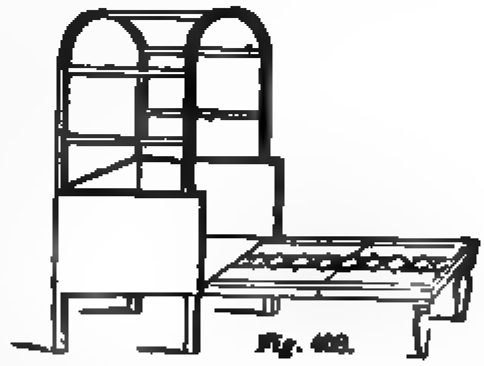


Fig. 408.

1196. *Press bedsteads* are made to shut up, when not in use, into a press which is generally low, and sometimes made to imitate a chest of drawers, or a cabinet. They are convenient in certain situations, as occupying little room, and not having the appearance of a bed; they are therefore useful in small rooms, where an ordinary bed could not be put. But they are liable to this objection, that, as the bedding is folded up in them during the day, it does not get so well aired as is requisite. Also, from the numerous joints and crevices in the wood-work, they are more liable to harbour vermin, and are more difficult to keep clean than other beds; they are therefore not to be recommended, except through necessity. If they are used, the construction that has the fewest joints in the wood-work is preferable. *Fig.* 409 represents a press bedstead turned town; the bed is placed upon the usual sacking, and the bedstead folds up in three lengths, the feet also folding down; the bed, bedclothes, bolster, and pillow, are put in over it, and when the doors are shut, the top (which is best in one piece, framed, if of deal, though usually made in two pieces,) shuts down over them. If this bedstead is to imitate a chest of drawers, instead of the folding doors, one door only must be made, having the external side to imitate drawers with handles; or, if it should be inconvenient to hinge it, it may be made a separate piece, to take off altogether. room, instead of making this press bedstead so est of drawers, a better plan is to make it go into a press six or seven feet high, by which only one joint is required in the bedstead, as in the half tester bed, *fig.* 407; the bed may be made in the morning, and strapped down before it is turned up, so as to be ready to sleep in on turning it down in the evening. The low press bed may also be made to imitate a dressing-table, or chest of drawers, covered with a toilet cover.

1197. *Chair beds* are convenient, as affording the means of accommodating an accidental visiter, when all the other beds are occupied. They are frequently so complicated as soon to be out of order. *Fig* 410 represents one free from that objection, and at the same time forming a complete arm-chair. The bed frame folds up into the seat of the chair; and the mattress is made in three pieces, two of which are used in the seat,

and the other one in the back. The light frame on the top is to support curtains if required, and it slides down into the back, the top being closed by a narrow-hinged fillet.

1198. *Sofa and couch beds* are made on a similar principle. *Fig.* 411 represents the framing of one so simple that it may be made by a common carpenter, of deal or any other wood: the back folds down to make the bed on the

sofa. The seat is formed of a frame lathed, and having a mattress laid on it in the usual manner of a sofa; this frame being hinged, lifts up and allows the bed-clothes, together with the bolster and pillows, to be put into the well below that reaches nearly to the floor, and is enclosed all round by canvass strained to the frame. Another mattress is required for the back, in addition to that which forms the seat of the sofa; the front rail must be strong, and of sufficient depth to bear the weight of sitting on the sofa; and to strengthen it, it will be necessary to have an iron bar under the middle of the seat. The back must be lathed like the seat, to keep in its place when raised up; a strong hook and eye will be sufficient. Small stuffed pieces must be made for the ends; and the whole may be covered by a loose covering of chints, to be taken off when the bed is to be made. Sofa beds are made of other constructions more elegant, and form useful and cheap pieces of furniture.

1199. *Cot beds or hammocks* are exceedingly convenient in many situations where there is little room, or when an extra bed is required. They are formed by making a wooden frame with sacking strained across large enough for one person. To the side of this canvass is attached, as in *fig.* 412, two poles, by which the cot is suspended to the ceiling by strong cords. It is easy to see how this might be made more ornamental by curtains. The great convenience is that, in the day-time, it is so portable that the whole may be easily put away. It is scarcely necessary to state that care should be taken to have the lines and hook sufficiently strong.

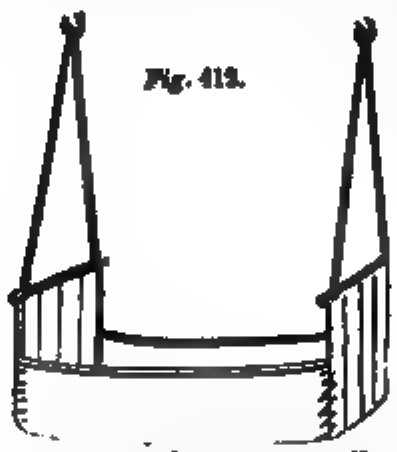


Fig. 412.

1200. *Stump bedsteads*, *fig.* 413, are the humblest in common use; they are usually made of wood with sacking bottoms.

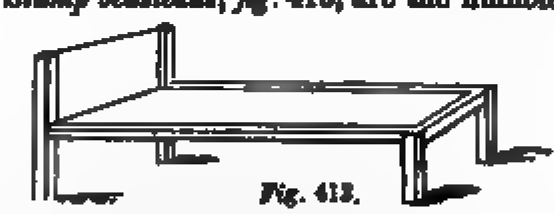


Fig. 413.

1201. *Box bedsteads* are a very ancient kind of bedstead, still used in many parts of the Continent, and in Scotland. They consist of an enclosure of wainscoting, sometimes moveable; but, however they might have been calculated for houses which were very pervious to the weather, they are not to be recommended, as they confine the air too much for health.

1202. *The folding camp*, or *tressel bedstead*, *fig.* 414, is one of the cheapest made, and has the great convenience of being easily put aside to make room when folded, consisting merely of two frames connected by the sacking. When extended, it is kept open by the head-board, which has two pins that drop into holes in the side rails, with the addition of a foot-board, made in the same manner as the head-board; there is no better bedstead for men servants or young people; and being so moveable, they are easily kept clean, not requiring taking to pieces. They may be had complete for less than £1. If required, nothing would be easier than to add curtains, in the manner of the French bedstead. They are also made sometimes of iron.

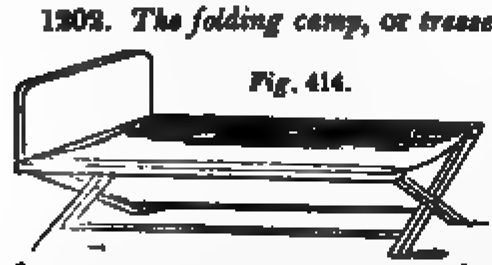


Fig. 414.

Camp bedsteads, to fold in little room, are made sometimes of iron; but the best and most elegant are of hollow brass rods, which are particularly convenient for travelling by land or sea, and are occasionally useful in the house from being easily put away. Those of brass are about twice the price of iron ones. Couches are made on the same principle.

1203. *Iron bedsteads* have now become very general, and are much more easily kept

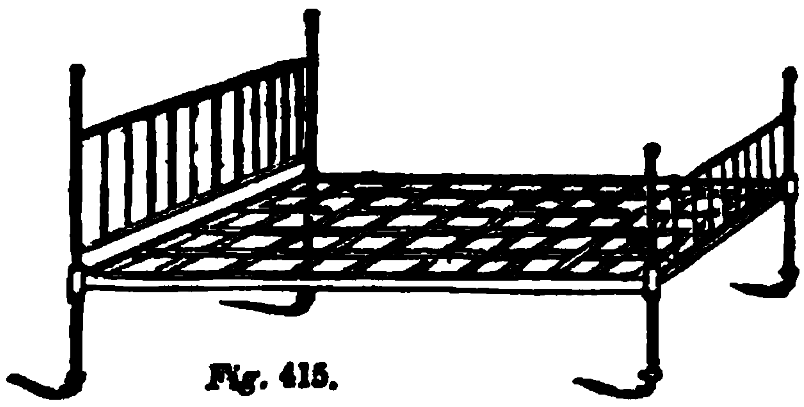


Fig. 415.

clean than those of wood. Though a little more expensive at first, they are often found cheaper in the end, on account of their greater durability. They are painted in oil; and the bottoms, instead of being of sacking, are composed of iron hooping, crossed, as in *fig.* 415. Some are made with standards for curtains, in the manner of French bedsteads.

1204. *Wire gauze is found very useful in tropical climates* as a substitute for the sacking, head, tester, and the various hangings of a bedstead, in order to prevent certain insects from establishing their domicil, and likewise the intrusion of winged insects and reptiles. To supply the place of ordinary curtains, the wire gauze is framed in panels, which are connected together by hinges, so as to allow any one of them to be opened at pleasure. The sacking, heading, and tester may be permanently fixed. A patent was taken out for this application of wire gauze by Briedenback of Birmingham.

1205. *It is necessary sometimes to take bedsteads to pieces*, for the purpose of having them cleaned; and though generally an upholsterer or a carpenter is employed to do this, yet it is proper that servants should perform an operation which is not difficult if done with regularity. An iron bed-key is requisite to undo the large screws by which the bedstead is held together, and all the parts should be marked, so that no mistake may be made in putting them together again.

1206. *Bedding.—Feather beds*, or beds stuffed with feathers, are now in universal use in this country. In these modern times of refinement and luxury, the good qualities of a bed are considered as of the first importance; and undoubtedly the restoration of strength after fatigue depends much upon the properties of this article of furniture; and health as well as comfort demands that its materials and construction should be well attended to. For the nature of feathers, and the mode of cleaning and dressing them, see Book V., Chap. V., "Materials for Furniture." The feathers are enclosed in a case of ticking. To prevent the feathers from coming through, which they are apt to do, and which occasions much of that dust commonly termed *flue*, so disagreeable in bedrooms, some rub bees' wax upon the inside of the ticking, or a mixture of bees' wax and yellow soap. This is necessary when the ticking is thin; but it is better to have the ticking so close and stout as not to require it; and to prevent the feathers from penetrating, the ticking is occasionally made double. Feather-beds, to be kept in good order, require to be well shaken every day, otherwise the feathers mat together in hard knots, that are difficult to undo and separate. When this has happened from long use or neglect, so that the beds are uncomfortable to those who sleep upon them, it is necessary to take the feathers out to have them dressed, and the ticking well washed, dried, and aired, if not renewed. The dressing of the feathers is usually performed by regular manufacturers, in which case it is necessary to take care that they do not keep back part of the feathers, which dishonest persons are apt to do. The process may be performed by any one in a house where there is a spare empty room. The feathers should be emptied in a sheet, and carefully loosened by hand, picking out all the quill parts from the light feathers. The loosened or cleared feathers are then to be returned by handfuls into the new ticking, through a part of the seam left unclosed for the purpose. It is scarcely necessary to add that this is a troublesome and unpleasant operation, from the feathery dust; while it is going on, the doors and windows of the room should be kept shut, to prevent the feathers flying all about. As there will be some deficiency of feathers by this process, and by constant use, it will perhaps be requisite to supply this by the addition of a portion of new feathers. If the feathers from the poultry are not given as a perquisite to the cook or dairy-maid, which is sometimes the case, they are often sufficient for this purpose; or these may be collected and kept for pillows, or any similar use. In this case, after being well selected, they should be put into strong brown paper bags, and well dried by keeping them several days in the oven after the bread is baked, until all smell is removed. They are then to be taken out, the quill parts cut off carefully, and the feathers cleaned according to the directions which we have given; they should then be restored to the paper bags, and kept in a dry place for use. Bed-ticking will last many years with care; in towns and smoky situations it may be advantageous to have coverings of brown holland, which can with ease be taken off and washed as occasion requires.

Formerly it was the custom to use only feather beds laid upon the sacking; but these beds were very thick, and contained much feathers. Economy and attention to health have introduced the custom of laying a thinner feather bed upon a mattress, and sometimes that upon a paillasse.

1207. *In purchasing feather beds*, the purchasers may choose their feathers, which are of various prices, at so much per pound; and they may see the ticking filled with them, having the quantity put in which they wish. If too much is put into the bed, it will feel hard.

1208. *Mattresses* are a firmer kind of beds, usually placed under the feather beds, but sometimes preferred to the latter for sleeping upon, as being less soft, and not so relaxing. They consist of a bag of canvass or ticking stuffed with various materials; but as these are not intended to be moved or shaken, they are fixed in their places by packthread put through, and tufts fixed at equal distances: the edge or border of the mattress is formed square. The materials with which mattresses are filled are usually horsehair, wool, flock, millpuff (a kind of coarse wool), chaff, straw, ulva-marina, cocoanut fibre, or coils of elastic wire. Hay and chaff are occasionally employed.

1209. *The best of these is good horsehair*, which, when of the first quality, preserves its elasticity a long time; but it is also the most expensive: in a second quality, the hair of the tails of oxen is mixed, and this is also good.

1210. *Wool mattresses* are much cheaper, but it is necessary that they should be made of good wool. The cheapest kind usually made in England are of wool rejected for manufacturing purposes, called flock, mixed with the waste from the surface in dressing blankets and cloth, which, being short, requires many tufts or knots to keep the wool properly in its place, and consequently the mattress is hard. In France, wool mattresses are very generally slept upon instead of feather beds, but these are made of long wool, which requires few tufts, and are very soft; these are beginning now to be made here, but they are expensive; and as they will get hard by constant use, and cannot be shaken up like a feather bed, they require occasionally to be taken to pieces by the upholsterer to have the wool carded and made up again, which costs eight or ten shillings. They are excellent for summer use, being less relaxing than feather beds, and not half the price.

An eminent upholsterer recommends as an excellent kind of mattress long wool and hair, not mixed together, but laid in alternate layers: this is less expensive than all hair, but nearly equal in quality. Four inches thick is sufficient for a mattress; thicker cannot be well fastened: when a very soft mattress is required instead of a feather bed, it is best to have two rather thin laid one on the other.

1211. *Mattresses stuffed with elastic iron wire* are a recent and valuable improvement. The following is the mode of constructing them: wire about the eighth of an inch in diameter, or smaller for some purposes, is twisted into coils of the form of an hour-glass, *fig.* 416, that is, like two cones joined together at their apices. The lower parts of the springs are sewed to a canvass or webbing, and their upper parts are secured in their places by packthread, tied or braced from one to the other, crossing like a net. On the tops of the springs canvass is laid, and over that a layer of baked horsehair, and then the outer covering of ticking. The springs are made at Birmingham. When the mattress is not pressed, the springs rise to their full height, which is about seven inches; but when the weight of a person comes upon it, the springs yield, and are compressed into less space. This kind of mattress, on account of its superior elasticity, is particularly well calculated for invalids, not requiring to be shaken or moved like a feather bed. It is, besides, extremely cool in summer; and in winter, if warmth be required, another soft mattress can be laid upon it. Indeed, with this mattress no feather bed is necessary, and it is therefore, upon the whole, very economical, not being above half the price of a bed. They cannot be turned, and require no making. The same method of stuffing by wire springs is used extensively for easy chairs, and seats of various kinds.

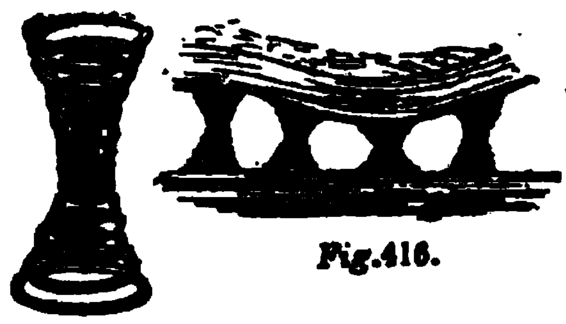


Fig. 416.

1212. *Cocoanut fibre*, called *coir* in India, has lately been introduced as a material for stuffing mattresses, and has some qualities that strongly recommend its use. These fibres are found surrounding the kernel of the cocoanut (see our description of that fruit, Book VII., Chap. IX.), and, after having undergone a certain preparation by the manufacturer, they are sold ready to use instead of horsehair. The advantages of this material appear to be these: containing naturally a large portion of tannin, a principle which exists in all bark, and which gives to leather its incorruptibility, it will neither ferment nor decompose, like other substances, but preserves its freshness in all climates. No vermin of any kind will breed or harbour in this fibre, although the best hair and flock are liable to this in warm countries. It is therefore exceedingly durable, and free from smell. It is also very elastic, and although not equal in this respect to the best horsehair, it is yet much superior to wool, nor does it get into knots like that substance. Cocoa fibre likewise preserves its elasticity for a long time, and this may be restored after some years, by taking it out, washing in water, and drying in the sun. This material has been tried by officers in the army and navy, and has been found particularly well calculated for mattresses, couches, and cushions: it is not above half the price of horsehair. It was first introduced by Captain Wilders.

1213. The *Ulva-marina* is a species of sea-weed, or marine plant (*Zostera marina*, Linn.), and this, when properly washed and dried, has been well spoken of as a stuffing for mattresses: it is very wholesome, does not harbour vermin, and is tolerably light

and soft; but if not sufficiently washed, is said to attract moisture, owing to a little salt remaining in it.

1214. *The outer chaff of the oat* is used for stuffing mattresses, and also bolsters, in some parts of Scotland. This material is carefully sifted from the smaller chaff and dust, and is renewed once a year.

1215. *The chaff of maize* is employed for the same purpose in Italy, and other countries where that grain is commonly cultivated.

Bran is sometimes used for mattresses for children.

1216. *The dried leaves of the beech-tree* are rather preferable to straw as stuffing for mattresses. Of these Sir Thomas Lauder observes, "We can, from our own experience, bear testimony to the truth of what Evelyn says as to the excellence of beech leaves for mattresses. We used always to think that the most luxurious and refreshing bed is that which prevails universally in Italy, which consists of an absolute pile of mattresses, filled with the elastic spathe of Indian corn; we mean that delicate blade from which the large head of the plant bursts forth. These beds have the advantage of being soft as well as elastic, and we have always found the sleep enjoyed on them to be peculiarly sound and restorative; but the beds made of beech leaves are really no whit behind them in these qualities, while the fragrant smell of green tea, which the leaves retain, is most gratifying. The only objection to them is, the slight crackling noise which they occasion when a person turns in bed; but this is no inconvenience at all, or if so, it is an inconvenience which is much overbalanced by the advantages of this most luxurious couch."

1217. *All mattresses lose their elasticity*, to a certain degree, by long use, and soon get so hard that they require to be taken to pieces and undressed. This is usually performed by the manufacturers, and it is more difficult to execute than in the case of feather beds. If of wool, this material must be taken out, washed, and carded. If of hair, this must be well loosened, and the dust beat and blown out with a bellows before it is returned into the new case. Great care must be taken to place the wool or hair exactly even, otherwise the inequalities will prove very unpleasant, and the fixing at equal distances with packthread, passed through at equal distances, must not be omitted.

1218. *Frauds are sometimes committed with respect to the materials of which mattresses are made*, and advice was given us by an upholsterer to recommend the purchaser who has reason to suspect fraud to open a portion of the sewing in the seam by cutting the thread, and with the fingers to pull from the very centre, between top and bottom, some of the material. Instead of the best hair mattresses, as ordered or described, it has been found that very inferior hair has been sometimes substituted; even a quantity of that from the hides of bullocks, goats, and deer, such as is used by the plasterers. In short, any description of hair that could be procured, and which is void of elasticity, perhaps mixed up with some good horsehair. In wool and flock mattresses, which latter are the cheapest, it is not uncommon to mix with the proper materials rag flocks, made from old blankets and flannels, and every kind of old woollen fabric, probably from hospitals, prisons, barracks, &c. These are torn or cut into shreds, and reduced to flocks by machinery, and carded.

1219. *A paillasse* is a very thick mattress stuffed hard with drawn wheat straw, the name being derived from the French, *paille*, straw. It is placed beneath the bed, and sometimes under the mattress, for the purpose of raising the bed, and giving it elasticity. When the bottom of the bedstead is made with laths, a paillasse is necessary, as the laths cut the mattress or bed. When two mattresses only are used, or a mattress and feather bed only, sacking is best to be under them.

1220. *Air beds* were invented by John Clark of Bridgewater, in 1813, in consequence of the previous discovery of rendering cloth impervious to air by means of Indian rubber. These beds, in fact, consist merely of a bed of the proper size of this kind of cloth, into which air has been forced by a pump through a stop-cock, till it is sufficiently inflated to serve as a bed, and then shutting the stop-cock. This case is then enclosed in another of ticking of any kind of cloth. This contrivance is capable of being particularly useful to many persons; for instance, to travellers, who, in transporting their beds, need, upon occasion, carry only a prepared bag and a force pump for air. Notwithstanding the great elasticity of air itself, these beds are not very elastic, but can never lose their elasticity so long as they are tight. They require no making up, can be got ready in a few minutes, and occupy little room when empty. The same invention is applied also to making elastic cushions to sit upon, very useful likewise to travellers; but it is to be observed that such beds will require very great care, as the smallest hole will render them useless.

1221. *Dr. Arnott's water bed* will be described under "Invalid Furniture."

1222. *The other parts of bedding*, such as blankets, sheets, and coverlets, have been treated of under "Woollen, Cotton, and Linen Manufactures," and the modes of cleaning them under "Laundry." Bolsters and pillows are usually stuffed with feathers, and the same observations apply to them as to beds.

Sect. II.—Bedroom chairs.

1223. *Bedroom chairs* are most usually made light, the seats of cane or rush, and they are generally painted or japanned. *Figs*. 417, 418, 419

Fig. 417.

Fig. 418.

Fig. 419.

1224. *Cheap light chairs* are made in great abundance of a great variety of patterns, of beech *stained* to imitate rosewood, with cane seats; most of these are made in Buckinghamshire. Loose cushions are sometimes laid on them. These are too well known to require farther notice. When well made, they form very tolerable cheap substitutes for rosewood chairs.

1225. *Common rush-bottomed chairs*, with the frames stained black, or painted, are by no means so good as the cane-bottomed, as the seats are liable to harbour vermin, and to be easily cut. They are much improved by painting the rush with oil paint, as then they can be washed with soap and water.

1226. *Fig*. 420 is a *devotional* chair, or *Prie-Dieu*.

Sect. III.—Couches, tables, dressing-glasses, etc.

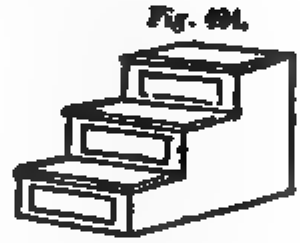
1227. *Figs*. 421, 422, 423 are *economical couches* for bedchambers or ladies' sitting-rooms: they may be made of deal, or other cheap wood, and have mattresses covered with chints, or even brown holland.

Fig. 421.

Fig. 422.

Fig. 423.

Fig. 424.



1228. *Bed-steps, fig*. 424, are necessary to ascend some beds that are made very high, and within is frequently placed a night convenience.

1229. *Toilet or dressing tables* are fitted up in an infinite variety of ways, from the plain table, with the toilet cover and mirror

placed upon it, to the most expensive kinds, and a proper selection adds much to comfort.

1230. *Fig.* 425 represents one of the most usual plain kind made at present. As this table is commonly placed against the window for the advantage of good light, if the mirror is placed upon it loose, it is very apt to be blown down, and perhaps broken, when the window is left open. The best way, therefore, is to have the mirror and frame to slide up and down by means of balance weights, as in a window sash. An additional shelf may be made to draw out to the right, to gain room if required: at the bottom is a cushion to put the feet upon. Toilet-tables are sometimes made extremely elegant and costly, with various contrivances for holding the numerous paraphernalia

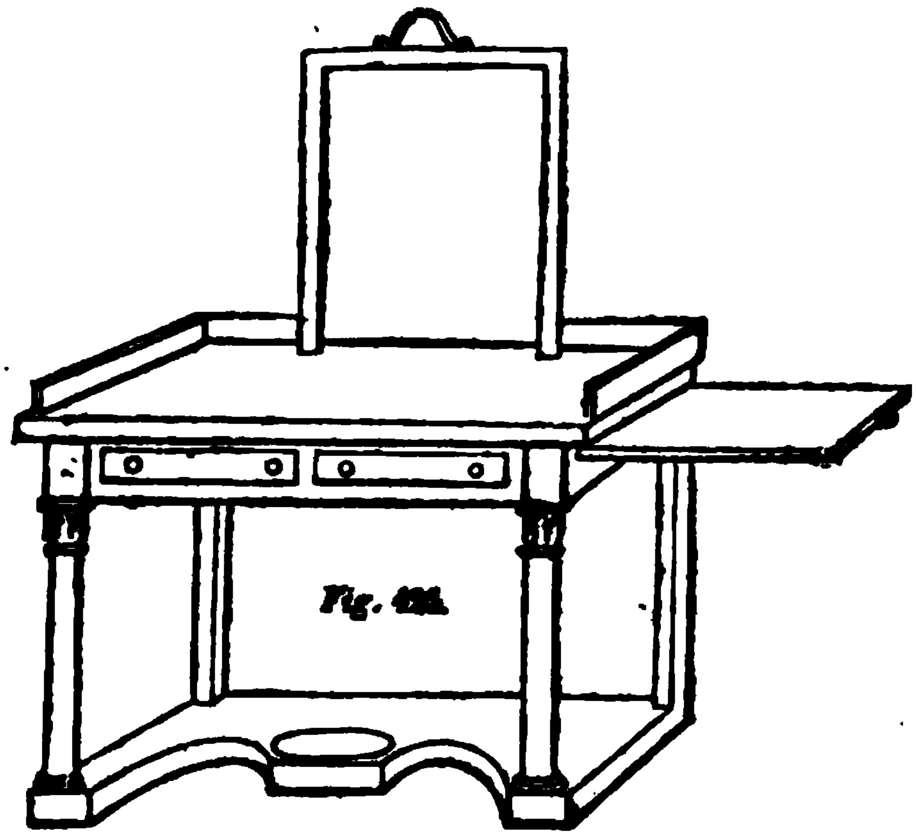


Fig. 425.

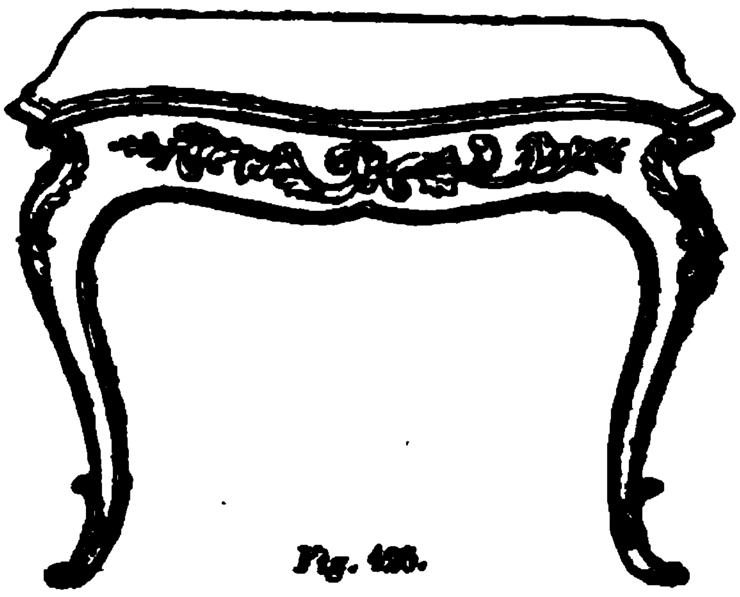


Fig. 426.

required by ladies; but we omit examples of these, since they must necessarily vary so much with the wants of individuals that no patterns can be established.

1231. *Tables in the style of Louis XIV., fig.* 426, are sometimes introduced into bedrooms and dressing-rooms as an agreeable variety. They are often of great elegance, having marble tops, and being decorated with brass ornaments, or inlaying with marquetry.

Figs. 427 and 428 are two tables in the Elizabethan style.

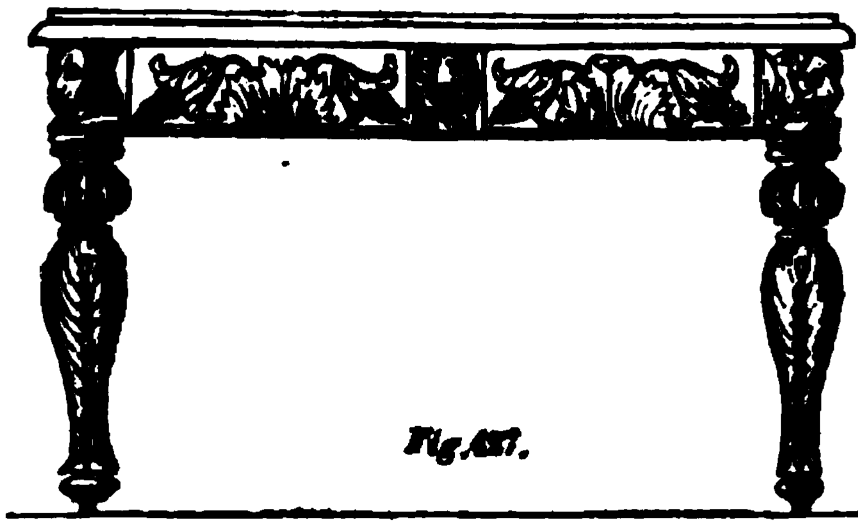


Fig. 427.

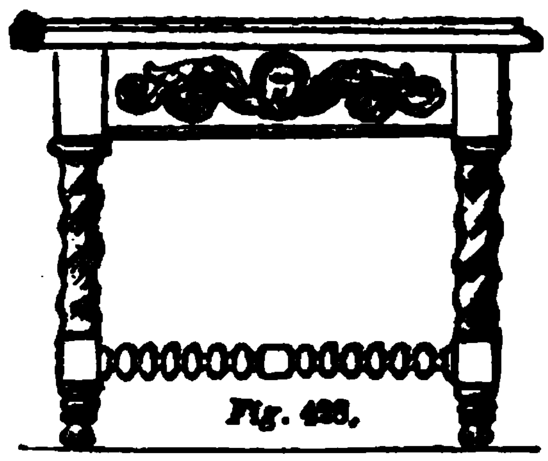
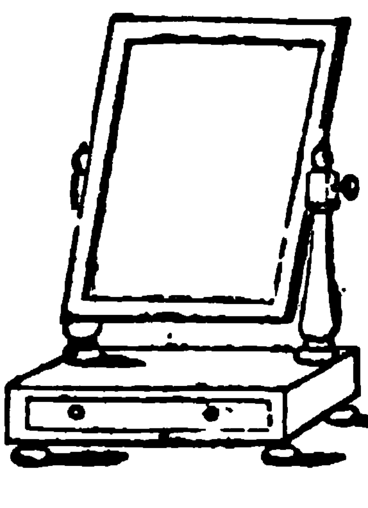


Fig. 428.

1232. *The dressing-glasses, or mirrors,* in common use are those termed *swing-glasses,* from their being moveable to any angle in a frame. *Fig.* 429 is a large *cheval glass* that

Fig. 430.



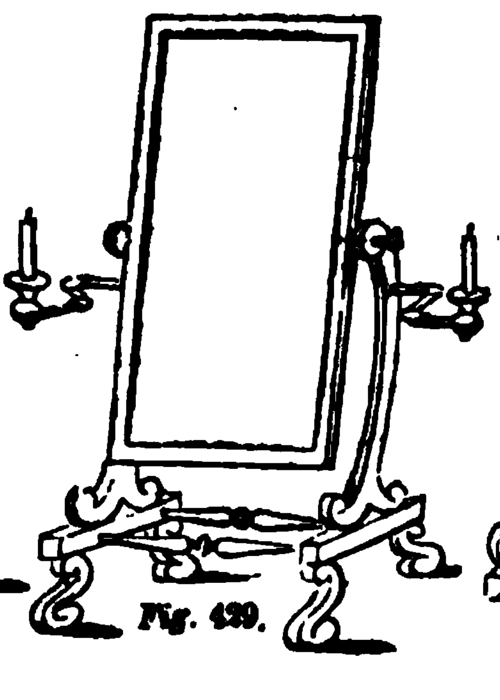


Fig. 429.

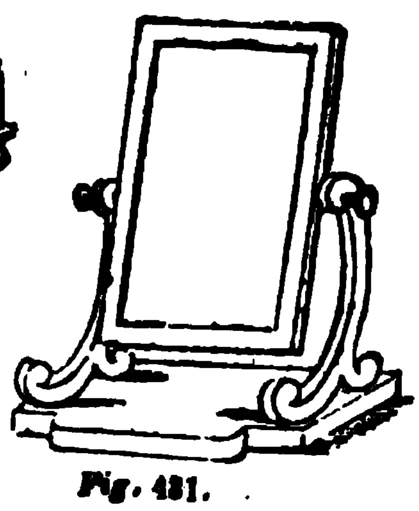


Fig. 431.

stands on the floor for viewing the whole person, with lights on each side. *Fig.* 430 is a small dressing-glass for the toilet-table, with a drawer. *Fig.* 431 is another with the drawer omitted, which is now usually done: this must be loaded at the bottom to prevent being easily thrown down.

1233. *Fig.* 432 is a *box-stool*, having the top stuffed to sit on, while the inside may hold caps, or other articles of dress, pinned to the girt in the lid.

Fig. 433 is a dressing-stool, light, with cane bottom.

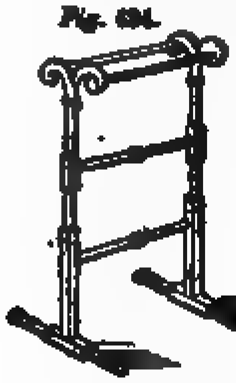
Fig. 432.

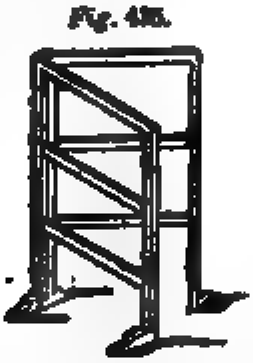
Fig. 433.

SECT. IV.—TOWEL AND WASH STANDS.

1234. *Towel and cloth airers.* *Fig.* 434 is the form at present most in fashion for towels. *Fig.* 435 is more convenient for airing clothes; from the mode in which the feet are fixed on, it will stand whether open or shut. *Fig.* 436 is still more convenient, as by means of a very simple hinge it may be made to fold backward, and in several different positions. *Fig.* 437 represents the hinge, which consists only of two strips of

Fig. 434. *Fig.* 435.





leather nailed on as in the woodcut: it may be made by any carpenter: there are four such hinges.

1235. *Wash-stands.*—These useful articles of furniture have been made in a great variety of forms, from which we select the principal varieties at present in common use.

Fig. 438 is the simplest kind of wash-stand, which may be made of deal painted, or any other kind of wood. The space below the basin, being enclosed with doors, may be used as a small cupboard. The wash-board is made high, and contains a small shelf. *Fig* 439 is a small wash-stand which was in general use some time ago, but is now seldom found except at the brokers: it is, however, very convenient for small apartments. *Fig.* 440 is one on a similar plan, intended for the corner of a small bedroom.

Fig. 439.

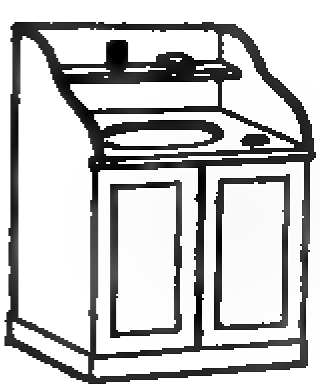
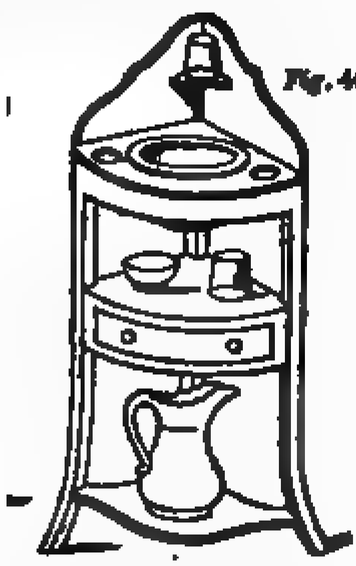


Fig. 438.

Fig. 440.



Figs. 441 and 442, wash-stands generally made at present. The top is usually made of marble, which is less apt to be injured by the alkali of the soap, which takes off oil paint, and spoils mahogany. Some kinds of veined marble, being now cheap from improvements in sawing, are very generally employed for this purpose. Below is a cir-

Fig. 4*2.

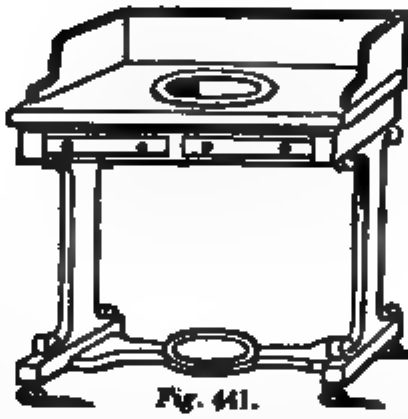


Fig. 441.

cular slab for the ewer. *Fig.* 443 is one on a similar plan, only not having the top perforated for the basin, so that it may be used occasionally also as a toilet-table. The basin and ewer may be put away upon the shelf beneath. *Fig.* 444 is a larger stand

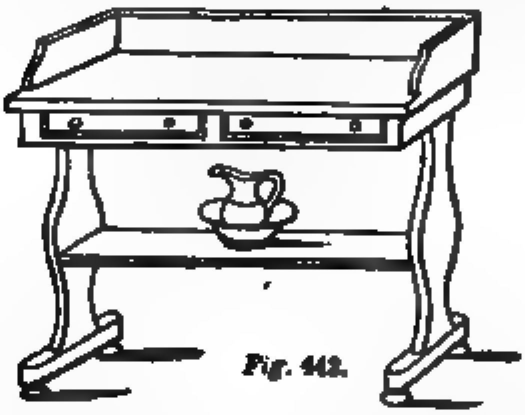


Fig. 442.

for two basins. *Fig.* 445 is a small mahogany wash-stand for a gentleman's room or library · the basin can be covered over with folding covers. *Fig.* 446 is a larger one for a similar purpose; the lid shuts down over the basin, ewer, and the toilet apparatus. In the lid is a mirror; and small drawers in front serve to contain various articles for the toilet. By means of handles at the ends, the whole may be readily moved from

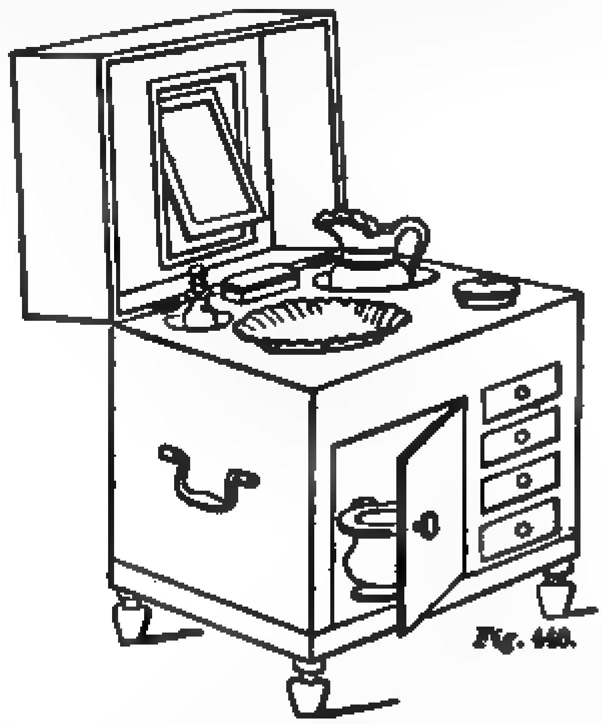


Fig. 446.

place to place as required. *Fig.* 447 is a wash-stand upon a very simple construction, with a small cistern at the top, and a plug in the basin, that the foul water may go into a vessel below. There is a mirror in the lid. *Figs.* 448, 449 are small wash-stands of elegant French patterns. They are executed in mahogany, and French polished.

A wash-stand, to be complete, should have, besides the basin and ewer, a carafe for spring water, vessel for hot water, soap tray, several glasses, and it would be better did it contain the necessary apparatus for shaving, &c.

1236. *Bed cupboards and night-stands.*—These conveniences are frequently made in the form of pedestals, either round or square; sometimes with a marble top, *figs.* 450, 451, which have a shelf in the middle. *Fig.* 452 is another variety, which has, instead of a door, sliders composed of a system of mahogany laths, so constructed as to slide round the corners, a plan which obviates the inconvenience sometimes occasioned by

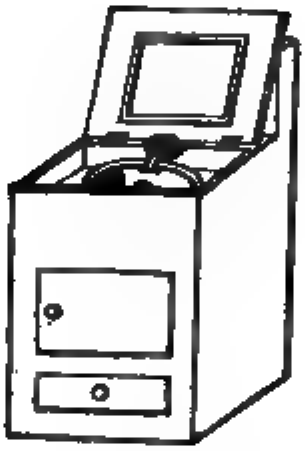


Fig. 447.

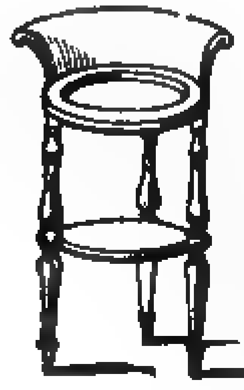


Fig. 448.

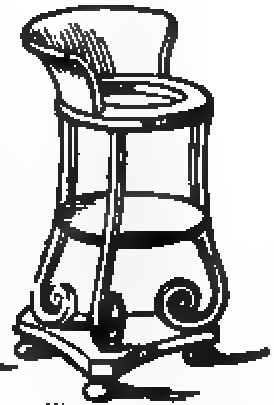


Fig. 449.

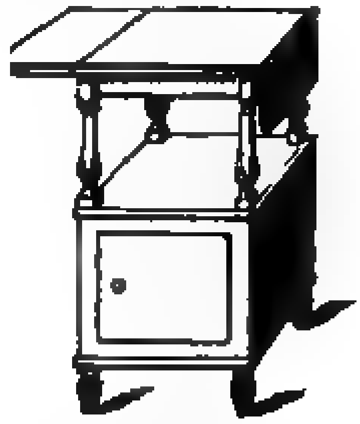
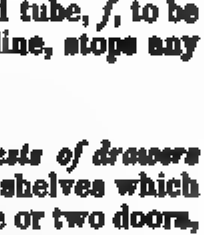


Fig. 450. Fig. 451. Fig. 452.

the projecting of a door when opened. p is likewise useful. *Fig.* 453 is one in which the top may be extended upon occasion by two folding leaves. It is easy to see how the advantages of the last two may be combined.

1237. *Portable water-closets* are useful where fixed ones cannot be had, and in case of sickness; as they may be placed in a dressing-room, or even a bedroom. If ill constructed, they are a nuisance; but we can recommend the following, patented by Wiss, near Charing Cross, London. *Fig.* 454, *a, a,* is the cistern for water, surrounding the three sides of a box which holds the pan, *b*; the cistern is filled by lifting up a small lid, *c*, and by pulling the handle of an engine, by which the water is forced into the pan through the washer. This water, by its weight, opens the hinged valve at the bottom of the pan, and carries the contents into a pail, *e*, placed beneath. This pail has a cover with a projection that dips into a groove containing a little water, that effectually prevents any effluvia from coming out. The pail can be removed to empty it. This apparatus may be made in a variety of forms; as a seat, an arm-chair, a commode, settee, &c. The same moveable box, with the cistern and pan, may be used



without a pail, and be more complete, where there is the convenience of connecting it with a pipe to go into a dram or cesspool. In this case there is a curved tube, *f*, to be joined to the pipe, which, being always full of water up to the dotted line, stops any smell from ascending.

Sect. V.—Wardrobes.

1238. *Wardrobes are far more convenient for keeping apparel than the chests of drawers formerly in general use.* In wardrobes, the dresses are hung up, or laid on shelves which draw out, and are therefore not injured by folding; also, by unlocking one or two doors, the whole is exposed to view, or secured by locking them, without the trouble of employing the lock and key of each drawer. Wardrobes are made of various forms and sizes, according to the particular uses for which they are required, or the expense to be gone to, and they are accordingly constructed of various woods, as mahogany, wainscot, or deal painted.

Fig. 455 represents one of the simplest and cheapest wardrobes, being a press with folding doors and sliding shelves. At the bottom is a deep drawer for holding bonnets and caps; these are best placed upon bonnet-holders within the drawer, *fig.* 456, or hung on hooks fixed in the inside of the drawers, as in *fig.* 457. Drawers certainly ex-

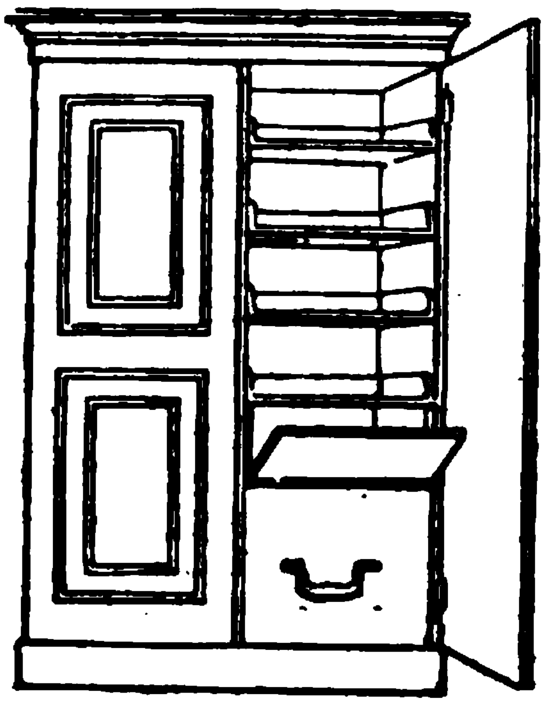


Fig. 455.

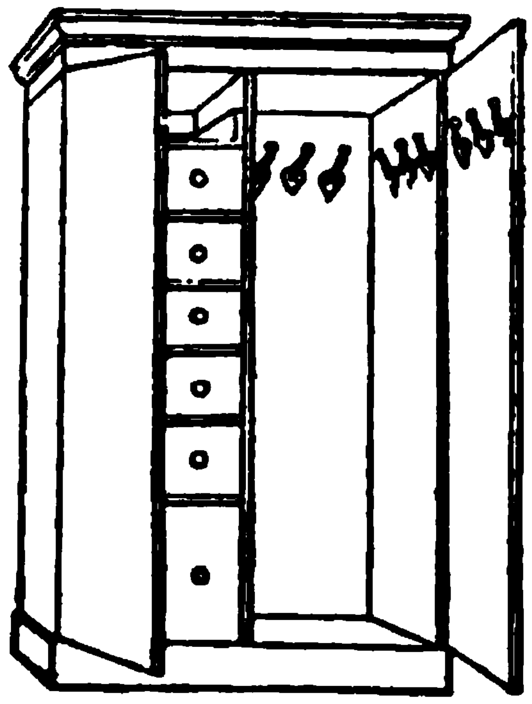


Fig. 459.

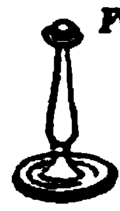


Fig. 456.

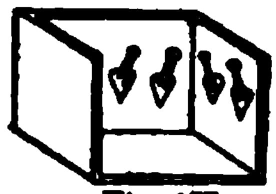


Fig. 457.

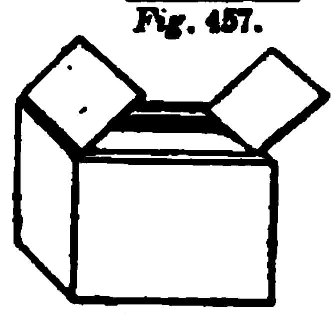


Fig. 458.

clude the dust better than sliding shelves; and they may be equally convenient if the fronts are made to fold down in the manner of a pianoforte; this is shown just above the deep drawer in *fig*. 455.

But the most complete mode of excluding all dust from delicate things is to have each drawer covered by four pieces of paper fixed by paste to the upper edges of the drawer. Two of these papers, which must be in width more than half that of the drawer, and consequently lap over each other, are first folded down, and over them the other two, as shown in *fig*. 458. In many cases two only will be found sufficient. The paper should be rather thin and pliable.

Fig. 459 is another wardrobe, with an upright partition in the middle; the space on one side has no shelves, but instead pegs at the top for hanging cloaks, dresses, coats, &c.; and cloak pins are also placed on the inside of the door to hang more things on. On the other side of the partition are sliding shelves or drawers.

Fig. 460 is a wardrobe of a more elegant design, executed in fine mahogany, and

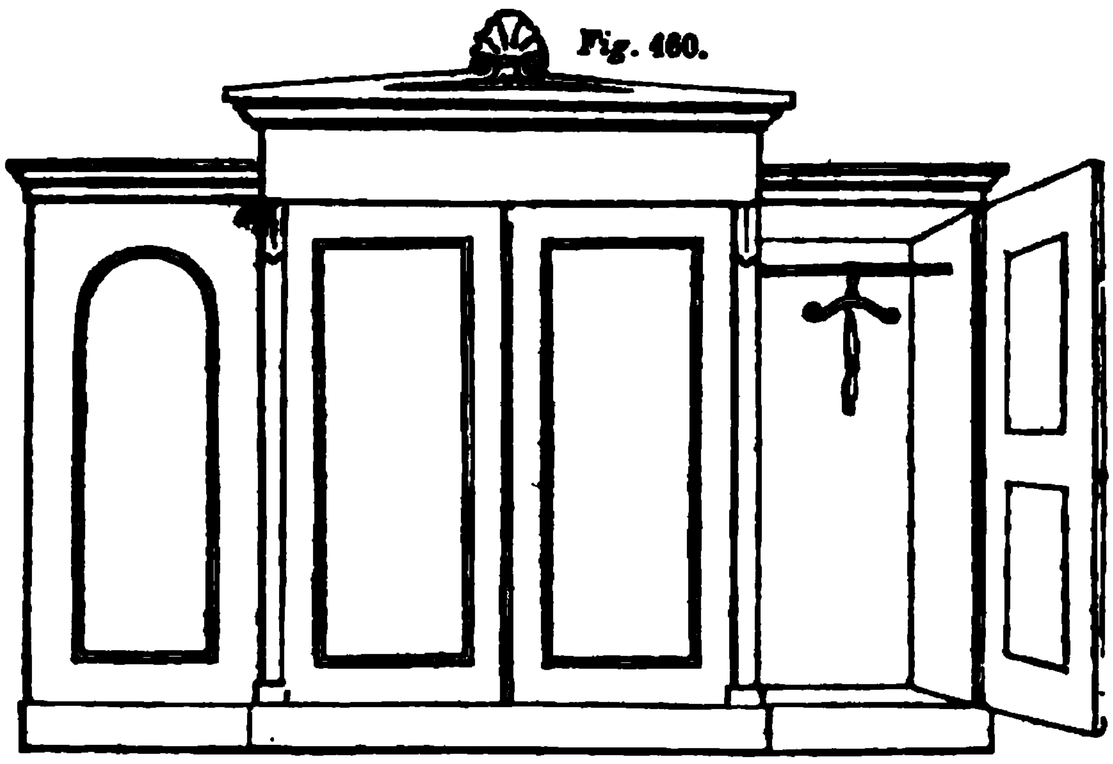


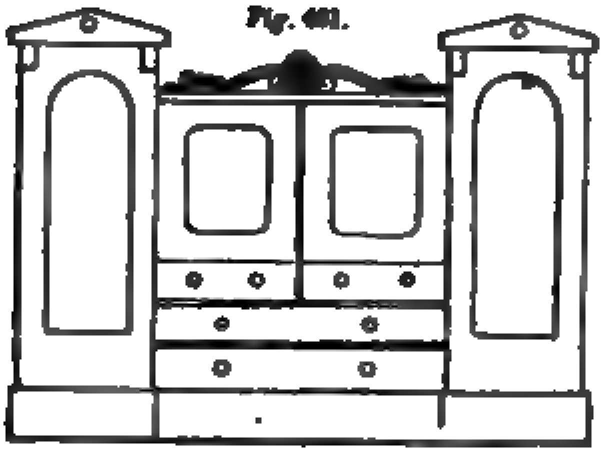
Fig. 460.

French polished. This is termed a *winged* wardrobe, from the pieces on the side of the central one. The central part contains sliding shelves or drawers, as may be found most convenient, or the upper part may have sliding shelves, and the lower part drawers; and the wings are for hanging dresses in; the most perfect mode of doing this is to put the dresses on the apparatus of brass represented sliding on a rod, and consisting of a handle and cross piece, something like a cross-bow. The cross piece goes into the arm holes of the dress, and several may be suspended on the same rod: by this means each dress may be easily seen and got at without disturbing the rest. One or two of the panels of the door of this wardrobe may be filled with mirrors.

1239. *Fig*. 461 is a *dwarf wardrobe*, proper when a small one is sufficient, or where there is not room for a larger. *Fig*. 462 is a small wardrobe of a very plain kind.

1240. *Small boxes* are likewise found convenient, in addition to a wardrobe, for holding various parts of dress or soiled linen. They may be fitted up to hold bonnets, caps, &c., and may be made of light materials, or strong, of wood: in the latter case they may be of the size proper for a seat, for which they may be used, having a stuffed cushion on the top, and the whole being covered with chints. A *settee or ottoman made to open* is useful to keep ladies' dresses in, when there is not a wardrobe or room for one.

Fig. 461.



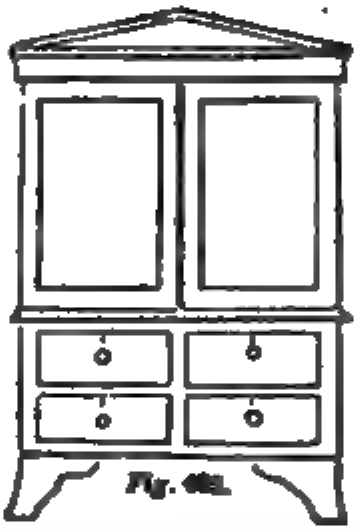


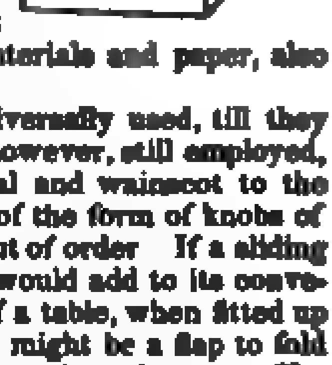
Fig. 462.

SECT. VI.—CHESTS, DRAWERS, ETC.

1241. *Chests or coffers*, often curiously carved in oak, and ornamented with hinges, escutcheons, &c., were among the ancient articles of furniture in England, and were originally almost the only contrivances for preserving clothes, books, or other valuable articles not in constant use. They were most usually separate constructions, but sometimes also formed part of the settle that stood in the chimney corner. The latter are still occasionally seen in old houses in remote parts of the country, but the greater part have been by this time chiefly bought up by upholsterers who manufacture ancient furniture. Plates of them may be seen in books on antiquities.

1242. *Traveling boxes, for caps or bonnets*, have a frame with a narrow girth crossed within, as *fig.* 463, to the under side of which the caps are pinned, so as not to touch the sides, or each other. Frills, laces, and light articles of that kind, are fixed upon the upper side of this network. Care should be taken to carry the boxes always top uppermost, and the caps will arrive at their destination without the slightest injury. The outside of the box is covered with some water-proof substance, as painted canvass.

Fig. 463.



1243. *Presses for linen* are made nearly in the same manner as wardrobes, with sliding shelves and drawers. They should have the names of the contents of each shelf pasted on the edge; there should also be deep chests in it, on castors, to draw out for dirty linen; and also spaces for baskets. If there is sufficient space, one compartment might contain a desk with writing materials and paper, also washing-book, &c.

1244. *Chests of drawers* are well known, and were once universally used, till they have given way, in a great measure, to wardrobes. They are, however, still employed, and may be purchased of various qualities and prices, from deal and wainscot to the best mahogany All the handles of the drawers are best when of the form of knobs of hard wood; brass tarnishing, and being otherwise liable to be out of order If a sliding shelf were made to pull out from below the top on occasion, it would add to its convenience as a table. Low chests of drawers of the usual height of a table, when fitted up in this way, are useful as an occasional writing-table; or there might be a flap to fold back on the top, and come forward, being supported by lopers, as in a bureau. We mention this, because it is very desirable that the varieties of useful furniture should be increased by the contrivances of individuals, and not be left entirely to manufacturers, who go on repeating the same forms, and seldom attempting novelties of a cheap kind, however useful they might be.

1245. *The commode* is evidently, from the name, of French origin, and appears to include a chest of drawers and chiffonnière, containing drawers below, and shelves with doors above. It is a very useful piece of furniture in a good bedroom, or a ladies' sitting-room. It may likewise serve as a bookcase.

1246. *Foot-pans* are either of wood, earthenware, or metal, as tin or zinc. Small tubs are apt to open in the joints when they stand by dry for any time; earthenware is free from that objection; but as the interior, being glazed, is unpleasantly slippery, it is best to have a loose piece of board to cover the bottom, loaded with lead to keep it down. They are now frequently made, in the form *fig.* 464, of zinc painted in oil. The vessel inside is for holding water.

1247. *Baskets*, so useful, are too well known to require

description; but a curious fact is not so much known, that in some countries they are so well made as to hold any liquid. Vaillant, in his travels among the South Africans, says, "Another offered me milk in baskets, a circumstance that astonished me. 'What,' exclaimed I, 'milk in baskets!' These baskets," he continues, "are very pretty, and fabricated with reeds so closely interwoven, that they will hold water:" and Barrow confirms this account of them. Several travellers have mentioned the ingenuity displayed in the manufacture of baskets among uncivilized nations.

1248. *Fire guards*, of painted wire, are so great a security against accidents from fire, that bed-chambers and dressing-rooms should never be without them; and, in general, they are proper to be used for all fires that are left for a considerable time to themselves.

1249. *The principal articles requisite for the dressing-room and toilet-table* are wardrobes; commodes; wash-stands; dressing-glasses; dressing-case, with razors; shaving boxes; hat, and clothes, and bonnet brushes; hair, tooth, and nail brushes; shoe lifts; boot and button hooks; tongue scrapers; cap and wig blocks; wardrobe powder, for dry-cleaning silks; corn rubbers; toilet cushions; braid combs of various sizes; powder boxes and puffs; towel airers; toilet covers; work-boxes, and loaded pincushions; candlestick stands; bonnet boxes; sponge and sponge bags; flesh brushes; soaps of various kinds.

CHAPTER XIII.

INVALID FURNITURE.

1250. Invalids frequently require peculiar articles of furniture to afford them ease and relief. Without attempting to detail all the contrivances for this purpose, which must vary in some degree with the particular cases, we shall give examples of such articles as, being frequently demanded, are usually made and kept for sale.

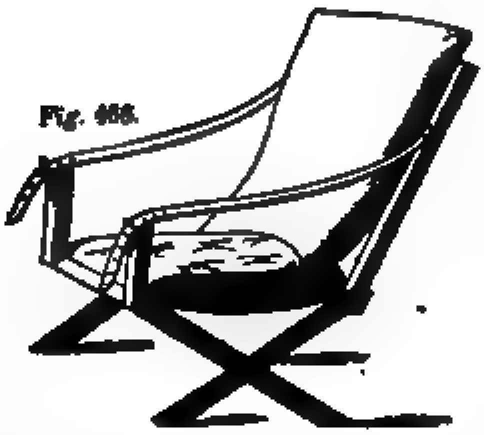
1251. *Reclining chairs* are found convenient not only for invalids, but for affording rest after fatigue, or for varying the position of the body on occasion. *Fig.* 465 represents one that, when upright, may be used as an ordinary chair; but by the back and seat sliding round on the circumference of the arched legs, the chair is brought into a position for reclining, as at *fig.* 466; and a rest for the legs and feet may be drawn out from beneath the seat. These chairs may be covered with Morocco leather, and stuffed. *Fig.* 467 is one where the back may be made to form any angle with the seat by a joint, and may be laid almost quite flat, the arms sliding in a groove in the frame of the seat.

Fig. 467.

1252. *The Douro chair*, *fig.* 468, is said to have been invented by the Marquis of Douro as a camp chair. The back is made to slope in any degree required, merely by shifting the holes in the leather straps by which it is supported; and it thus becomes a very economical and comfortable easy or arm chair. To render it portable, the frame is made to fold up flat with the greatest facility, and the stuffed back and seat being laid upon it, the whole is strapped into a square package.

1253. *A rocking chair*, for exercise, is represented in *fig.* 469. It is made wholly of iron, with a stuffed covering, but not very heavy.

Fig. 469.



1254. *The Merlin chair*, *fig.* 470, is a very ingenious invention, by which an invalid may move himself to any part of the room, by turning the handles which move the wheels of the chair by means of pinions on axles: but it is to be observed that it requires some little practice to learn the manner of working this chair; on which account the construction, *fig.* 471, is preferable, in which the two large wheels of the chair are moved by the invalid laying hold of a smooth mahogany circular rim outside the wheels, and of a smaller diameter, and which is several inches distant from the wheels. There are handles at the back for an assistant, if necessary.

Fig. 472 is the *Bath rail chair*, for exercise out of doors, to be drawn by an assistant.

Fig. 473 is the *sofa britska carriage* for persons who have spinal complaints.

All these articles of invalid furniture are made by Mr. Griffin, of Leicester Square, London, who has paid particular attention to the subject.

1255. *Fig.* 474 is called a *walking-horse*, and is for assisting a person to stand and move about who is too weak to be able to stand without such assistance; the body of the person goes within the hoop at the top.

1256. *Leg rests* are used in cases of gout, or any complaint in the legs that requires them to be kept up in a certain position. *Fig.* 475 is the simplest, consisting merely of two pieces of board at right angles to each other, one of them being covered with some stuffing, or only baize. *Fig.* 476 is a more complete one, made of mahogany, well stuffed, and so as to be raised to any desired angle by a rack.

Fig. 474.

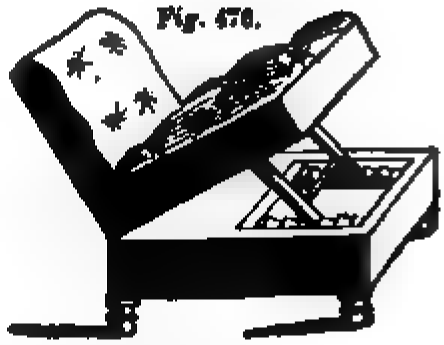


Fig. 475.

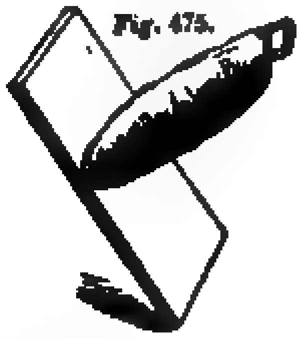


Fig. 476.

1257. *Bedsteads for the sick and wounded* are eminently useful in alleviating their sufferings, by affording them ease in changing their position, or removing the pressure upon a particular part of the body; many contrivances have been made for this purpose, and employed in hospitals, as well as other places.

Fig. 477 is the simplest, consisting of an ordinary bedstead with a part of the sacking made to raise at the head, so as to support the back of the invalid: this may be elevated to any angle by two upright pieces with holes and pins through the bedframe.

Fig. 478 is called a *bed chair*, and is placed behind the back of invalids in bed, to enable them to sit up. It may be elevated to any required angle by means of a rack behind.

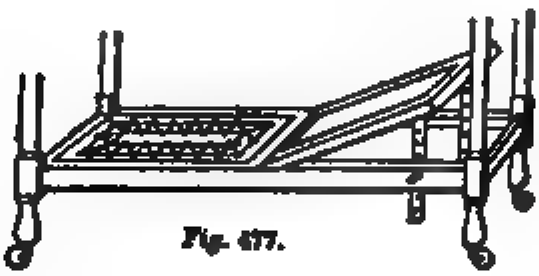


Fig. 477.

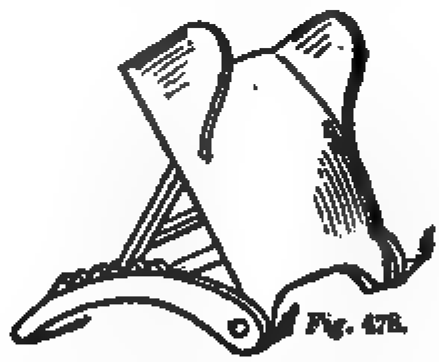


Fig. 478.

1258. *A bed table for invalids, fig.* 479, is made so that the foot of it can be put under the bed and the top project over. It may have a reading-desk or not, as required. The top is made to rise higher or be lowered, and is fixed at any height by means of a screw, as at *a*, or as at *b*, in which, by turning the handles, the table is raised or lowered. The foot should be made heavy by lead underneath, and the top should turn round upon the stem. It may be made of mahogany, or any other kind of wood, according to price, and the top may be made with various conveniences, as at *b*, with a board for draughts, or any other game, and a well below to keep cards, chess-men, &c.

Fig. 479.

Fig. 480 is an *invalid couch*, contrived to raise the back to any angle, and to conform to the situation of the legs, by elevating part of the frame by means of a winch acting

on levers by bands. This is usually called a *fracture bed*, and is made by Mr. Chapman, of Denmark-street, Soho, London. It has been recommended by Sir Benjamin Brodie, and other eminent surgeons.

1259. *An elastic or swinging seat, couch, or bed*, for counteracting the uneasy motion of a ship or carriage, and thus preventing sickness, was invented by Mr. Pratt of Bond-street. To effect this, the frame of the seat or couch is suspended on juribals or joints, turning at right angles to each other; and an elasticity is produced both in the seat and cushion, and in the swinging frames, by the use of spiral metal springs, which, it appears, were first introduced by Mr. Merlin seventy years ago, but which had been neglected until lately.

1260. *A bedstead for invalids* was also invented by Mr. Cherry of Coventry. The sacking is attached to a cylinder on each side of the bed, and running lengthwise: these cylinders contain springs by which the sacking is kept always stretched when not in use; but when it receives the weight of the body, the springs give way a little, and the bedding sinks down several inches into a concave form, by which it encompasses the sides of the patient, and relieves the back from sustaining the whole weight. The patient may also, by the construction of the bed, be placed in any required position; and the bedstead may be converted into an easy chair.

1261. *The invention of cloth impenetrable to fluids* has given rise to invalid beds of an excellent kind. So long ago as 1819, Joseph Pierre Gros, member of the Medical Athenæum at Montpelier, published a thesis read to the Ecole de Médecine of Paris, in which he states that he had employed water for this purpose, which, he observes, possesses three important characters, viz., perfect softness, arising from the mobility of its particles, capacity for caloric, and the susceptibility of being contained in an envelope impenetrable by the excrementitious matters of the sick, and being inaccessible to contagious miasma. This thesis is preserved in the library of the Ecole de Médecine of Paris.

1262. *Dr. Arnott's hydrostatic bed* is particularly useful for invalids, and we cannot do better than give the description of it in his own words: "In many of the diseases which afflict humanity, more than half of the suffering and danger is not really a part of the disease, but the effect or consequence of the confinement to which the patient is subjected. Thus, a fracture of the bone of the arm is as serious an injury as one of the bones of the leg; but the former leaves the patient free to go about and amuse himself, or attend to business, as he wills, and to eat and drink as usual — in fact, hardly renders him an invalid; while the latter imprisons the patient closely upon his bed, and brings upon him, first, the irksomeness of the continued position, and then the pains of the unequal pressure borne by the parts on which the body rests. These, in many cases of confinement, disturb the sleep and the appetite, and excite fever, or such constitutional irritation as much retards the cure of the original disease. That complete inaction should prove hurtful to the animal system may by all be at once conceived. The operation of continued local pressure will be understood from the following statements: The health, and even life, of every part of the animal body depends on the sufficient circulation through it of fresh blood, driven in by the force of the heart. Now, when a man is sitting or lying, the parts of his flesh compressed by the weight of the body do not receive the blood so readily as at other times; and if, from any cause, the action of his heart has become weak, the interruption will both follow more quickly and be more complete. A peculiar uneasiness soon arises where the circulation is thus obstructed, impelling the person to change of position; and a healthy person changes this as regularly and with as little reflection as he winks to wipe and moisten his eyeballs. A person weakened by disease, however, while he generally feels the uneasiness sooner, as above explained, and therefore becomes what is called restless, makes the changes with much fatigue; and should the sensations after a time become indistinct, as in the delirium of fever, palsy, &c., or should the patient have become too weak to obey the sensation, the compressed parts are kept so long without their natural supply of blood that they lose their vitality, and become what are called sloughs, or mortified parts." Dr. Arnott then describes some cases of that kind, and continues: "Under these circumstances, the idea of the hydrostatic bed occurred to me. Even with the pressure of an air pillow, it was evident that persons in such a condition could not be saved unless they could be supported without sensible inequality of pressure. I then reflected that the support of water to a floating body is so uniformly diffused that every thousandth part of an inch of the inferior surface has, as it were, its own separate liquid pillow, and that no part bears the load of its neighbour; that a person resting in a bath is nearly thus supported; that a patient might be laid upon the surface of a bath over which a large sheet of the water-proof India-rubber cloth was previously thrown, the body being rendered sufficiently buoyant by a soft mattress placed beneath it. Thus the patient would repose on the face of the water, like a swan on its plumage, without sensible pressure anywhere, and almost as if the weight of the body was annihilated. The pressure of the atmosphere on our bodies is fifteen pounds per square inch of its surface, but, because *uniformly diffused*, is not felt. The pressure of a water-bath of

depth to cover the body is less than half a pound per inch, and is similarly unperceived. A bed such as this was made. A trough of convenient length and breadth, and a foot deep, was lined with metal to make it water-tight; it was about half filled with water, and over it was thrown a sheet of the India rubber cloth, as large as would be a complete lining to it if empty. Of this sheet, the edges, touched with varnish to prevent the water creeping round by capillary attraction, were afterward secured in a water-tight manner all round to the upper border or top of the trough, shutting in the water as closely as if it had been in bottles; the only entrance left being through an opening at one corner, which could be perfectly closed. Upon this beautiful dry sheet a suitable mattress was laid, and constituted a bed ready to receive its pillow and bedclothes, and not distinguishable from a common bed but by its most surpassing softness or yielding. It may be here recalled to mind that the human body is nearly of the specific gravity of water, or of the weight of its bulk of water, and therefore, as is known to swimmers, is just suspended or upheld in water without exertion, when the swimmer rests tranquilly on his back with his face upward. He then displaces water equal to his own body in weight as well as in bulk, and is supported as the displaced water would have been. If his body be two and a half cubical feet in bulk (a common size), he will just displace two and a half cubical feet of water, equal in weight to his own body. If, however, instead of displacing the water with his mere body, he choose to have something round or under him which is bulky with little weight, as the mattress of the bed above described, when his weight has forced two cubical feet of that under the level of the water around, he will float with four fifths of his body above the level, and will sink much less into his floating mattress than a person sinks in an ordinary feather bed. It thus appears that, by choosing the thickness of the mattress, and, if unusual positions are required, by having different thicknesses in different parts, or by placing a bulk of folded blanket or of pillow over or under the mattress in certain situations, any desired position of the body may be easily obtained. If the water be about six inches deep, which, in general, will suffice, the person standing upon any part of the bed, or sitting with the knees raised, will cause the part of the mattress on which he rests gently to touch the bottom, because a narrow end of the body cannot displace water equal to the bulk of the whole; but then the person is standing or sitting upon a soft sofa, and in standing or sitting, he naturally prefers the fixed to the floating support: on lying down, however, he as completely floats as if the Atlantic were under him.

"This bed is warm, owing to water being nearly an absolute non-conductor of heat from above downward, and owing to its allowing no passage of cold air from below. From this last-mentioned fact, however, less of the perspiration, sensible and insensible, will be carried off by the air than in a common bed; and unless the patient can rise, or be lifted daily, to allow the bed to be aired like a common bed, there will be a necessity for using some such means as the following, to prevent the condensation of perspiration on the water-sheet below: An oiled silk laid over the mattress, or a blanket, to be occasionally changed, laid under it, or a set of flexible tubes of spiral wire laid under it, with their ends open to the atmosphere, to ensure a constant ventilation of the mattress; or, similarly placed, and producing the same effect, a layer of cork cut into square pieces, with spaces left between them as conduits of air. This bed is in itself as dry as a bed can be, for the India-rubber cloth (of which bottles can be made) is quite impermeable to water. Then some persons may prefer having a double sheet of it, to prevent the possibility of accident. Unlike any other bed that ever was contrived, it allows the patient, when capable of only feeble efforts, to change his position, almost like a person swimming, and so to take a degree of exercise affording the kind of relief which, in constrained positions, is obtained by occasionally stretching, or which an invalid seeks by driving out in a soft-springed carriage." Dr. Arnott then states that it has been introduced with success into several hospitals. He observes, "If used without the mattress, it becomes a warm or a cold bath, not allowing the body, however, to touch the water; and in India it might be made a cool bed, for persons sick or sound, during the heats which there prevent sleep and endanger health. Before reflection, a person might suppose a resemblance between it and an air bed or pillow, calling this a water bed or pillow; but the principles of the two are perfectly distinct or opposite. An air-pillow supports, by the *tension of the surface*, which encloses the air, and is therefore like a hammock or the tight sacking under the straw mattress of a common bed, and really is a hard pillow; but in the hydrostatic bed there is no tense surface, or wet at all: the patient is floating upon the water, on which a loose sheet is lying, merely to keep the mattress dry, and every point of his body is supported by the water immediately beneath it. To recall the difference here described, and which is of great importance, the bed is better described by the appellation of *hydrostatic bed* than of *water bed*.

The envelopes made at present to contain water for beds are liable to a defect, that the canvass, which is always in contact with the water, decays in a short time, generally in a year, and sometimes in six months, and the whole water-tight case then requiring to be renewed; this not only creates a considerable expense, but the renewal

cannot be effected in every place. Some material of superior manufacture might, perhaps, obviate this difficulty.

1263. *Sedan chairs*, once so common, are now scarcely known, except as a conveyance for invalids. They were first introduced into England in the reign of James I., when they were used by the Duke of Buckingham, to the great indignation of the people. Towards the end of the reign of George III. the increase of carriages occasioned them to be gradually laid aside.

CHAPTER XIV.

FURNITURE OF THE NURSERY.

1264. The furniture of the nursery ought to be very simple, and should consist of no more things than are absolutely necessary. We refer the reader to Book XXII., "On the Nursery," and propose at present to describe such things as can be illustrated by figures.

1265. *The bassinet*, *fig*. 481, is usually the first thing the infant is put into. It is, in fact, a basket, with a hood which may fall backward if required. It has a hair mattress, stuffed very soft, and a small soft pillow; it is lined within, is very convenient for carrying about without wakening the child, and is much warmer than a large cradle or bed. It is generally made of wicker, about 2½ feet or 3 feet long, 18 inches wide, and fifteen deep, and is usually ornamented with muslin, ribands, &c.

1266. *Cradles* have been used from time immemorial, and the rocking has been thought necessary to cause children to sleep; but rocking and swinging are now generally condemned by medical men. Rocking is liked by nurses, who find it convenient in sending infants to sleep when they ought, perhaps, to be carrying them about in the open air, until at last, from habit, they will scarcely sleep without it. When children are in good health, they require no rocking; nevertheless, in certain cases, it appears to be useful in allaying irritation, particularly in a state of disease. They are usually made of basket-work, *fig*. 482, but also of other materials.

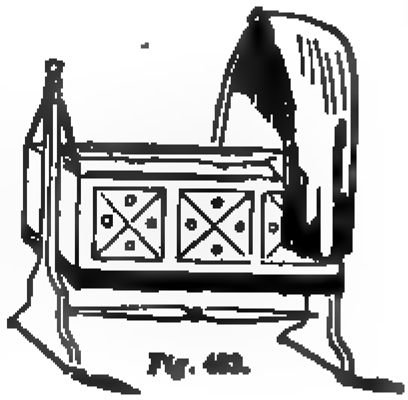


Fig. 483.

In the swinging cot, *fig*. 483, the motion is more gentle than in the cradle.

1267. *Cribs*, *fig*. 484, are more generally used at present. These are small bedsteads, supported on feet of such length that the height of the crib may be the same as that of the mother's bed, close to which it is placed in the night; one side is made to slide out in a groove in the uprights. The sides are frequently filled in with cane-work, or small balustrades; but care should be taken to have the cribs also lined inside, for it has sometimes happened that the child's fingers have been hurt by getting them in the openings. They are put on castors, and may be made to take to pieces, and put up very easily for travelling.

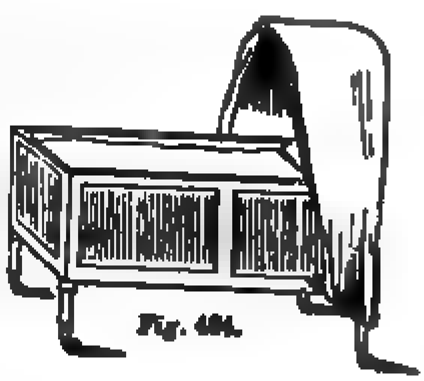


Fig. 484.

1268. *Children's chairs* are of various kinds, varying with their age. *Fig*. 485 is a little chair without legs, which some use to place very young children who cannot support themselves: it has a stuffed seat.

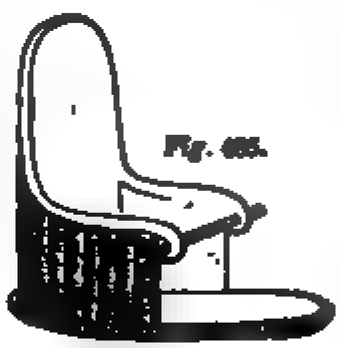


Fig. 485.

Fig 486 is a child's chair, called a *Bergère*, used when they begin to sit at table. There is a bar across to prevent the child's falling, and this bar should have a fastening to prevent its getting out, which it is apt to do. The chair has also a foot-board, which may be placed at different heights, and is placed upon a square stand to raise it to the table. At other times the stand itself may form a table for the child to put its playthings on.

Fig. 487 is a similar chair of a different pattern, and high enough to do without a stand.

Fig. 488 is a chair called an *Astley Cooper's*, because recommended by him; the back is high, to afford a support for the child, and prevent it stooping when placed at table; but this form is not universally approved of, and is objected to by some medical men.

Fig. 488.

Fig. 488.

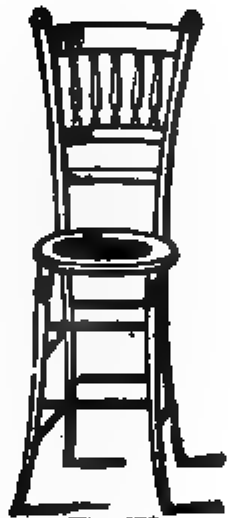


Fig. 489.

1269. *Child's bath.* This is a large earthen-ware basin fixed in a stand of wood, *fig.* 489.

1270. *Earthen-ware* vessels of various kinds are made on purpose for the nursery, and are kept at most of the respectable shops that sell earthen-ware. They are made plain, *fig.* 490. and of convenient forms.

Fig. 490 is a sucking bottle, the use of which is well known.

1271. *The nursery lamp,* for keeping liquids warm in the night, or for warming anything in the day when there is no fire. *a b*, *fig.* 491, is a cylinder of tin, within which a lamp is placed upon a shelf that is moveable up and down by means of a slit in the tin cylinder, and a screw, *d*, that fixes it at any particular height from the vessel holding what is to be warmed and placed on the top. This vessel may be of tin, or earthen-ware, or porcelain, or it may be a small tea-kettle, all of which must fit exactly within the top. At *e f* there should be small apertures to let out the smoke and hot air, otherwise the lamp will not burn; and there must also be apertures below the lamp to supply air. If, instead of a tin cylinder, there is one of wire gauze, the lamp will also afford light, and yet be perfectly safe; and it may be then made use of, on occasion, as a housemaid's safety lamp. Should a stronger heat be wanted, without smoke, the chemical Argand lamp with a copper tube may be used, which, in a few minutes, would boil water enough for one person's breakfast. The handle is not represented in the woodcut.

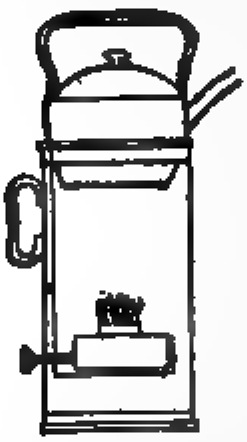


Fig. 491.

1272. *The nursery milk-warmer*, *fig.* 492, is a very useful apparatus, on the principle of the balneum mariæ, or water-bath. It consists of a small saucepan of tin to hold water, and another to fit within, but not to reach to the bottom of the external saucepan. This has a cover of the same material. This utensil effectually prevents the common accident of burning when anything is heated, because whatever is put into the inner vessel can be no hotter than boiling water, or 212°, a heat not sufficient to burn. The inner vessel is sometimes made of white glazed earthenware.

Fig 493 is more easily kept clean.

Fig. 494 is a section, by which the principle may be more easily seen; a small one may be used over the nursery lamp.

Fig. 492.

Fig. 493.

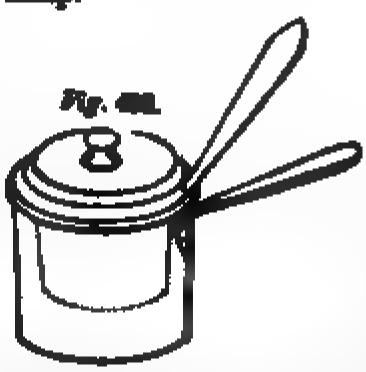
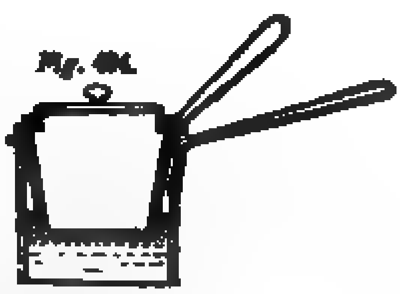


Fig. 494.



1273. *Wire guards for the fire* should never be omitted in a nursery.

1274. *Fly guard.* It has been lately discovered that a net placed across a window on the outside will effectually prevent the entrance of flies when the windows are open. The net may be stretched on a frame to be fixed within the reveals of the window. Whether from the fear of entangling their wings, in consequence of their experience, or for some other reason, they avoid trying to come through a net, even when the meshes are as wide as nearly an inch square, and the net made of black thread.

1275. *If balconies are used* before nursery windows, care should be taken that the bars are very close, as instances have been known of children getting their heads out between the iron bars, which were obliged to be cut through before they could be rescued from their dangerous situation.

1276. *A complete list of furniture* may be found convenient to refer to in arranging an establishment.

FURNITURE OF THE HALL AND STAIRCASE.

Door scrapers and brush.	Chairs.	Mats.
Cloak and hat stands.	Benches.	Letter box.
Cloak rails.	Floor cloth.	Lamps.
Umbrella drains.	Stair carpet and rods.	Stove.

FURNITURE OF THE PRINCIPAL APARTMENTS.

Window curtains.	Tapestry.	Music stool.
Window blinds.	Pictures and statues.	Canterburies.
Carpets and druggets.	Vases and various ornaments.	Tea equipage.
Tables and stands.	Book cases.	Tea poise.
Sideboards and cellarets.	Book shelves.	Cheffoniers.
Moving sideboards.	Writing tables.	Fire-screens.
Rising tables.	Writing desks.	Folding screens.
Dumb waiters.	Secretaries.	Hand screens.
Sofas and couches.	Bureaus.	Hearth rugs.
Ottomans and divans.	Cabinets.	Bells, ropes and pulls.
Chairs and seats.	Portfolio stand.	Table bells.
Stools.	Inkstands.	Lamps.
Mirrors.	Music stands.	Candlesticks.

FURNITURE OF BEDCHAMBERS AND DRESSING-ROOMS.

Beds and bedding.	Toilet tables and apparatus.	Cabinets.
Chairs and couches.	Dressing glasses.	Chests and coffers.
Carpets and hearth rugs.	Mouth glasses.	Bonnet boxes.
Matting.	Wardrobes.	Wash stands.
Bed steps.	Chests of drawers.	Chamber horses.
Window curtains.	Commodes.	Towel airers.
Blinds.	Hassocks.	Foot baths.
Baskets.	Night bolts.	Water cans.
Night convenience.	Boot hooks.	Baths.
Dressing cases.	Shoe lifts.	Clothes brushes.
Shaving pots.	Wax tapers and stands.	Alarm rattles.

FURNITURE OF THE NURSERY.

Bassinets and cradles.	Baths.	Pap boats.
Nursing and rocking chairs.	Shower baths.	Earthen-ware.
Astley Cooper and wicker do.	Nursery lamps.	Baby linen baskets.
Washing stands.	Sponges.	

CHAPTER XV.

EARTHEN-WARE, INCLUDING PORCELAIN.

SECT. I.—HISTORICAL REMARKS ON POTTERY.

1277. *The produce of the potter's art is the more interesting, as it is every day subject to our observation.* Not a day passes but we receive more or less pleasure from the neatness and beauty of those vessels from which we take our breakfast beverage, or our evening's refreshment. Vessels made of baked earth capable of holding liquids doubtless preceded those of metals; and the possession of the potter's art marks a certain advance in civilization, although we find that it existed among nations of the highest antiquity, when still in a very rude state. This invention was probably coeval with that of making bricks, which, we know, was practised at the building of the tower of Babel 2200 years before the commencement of the Christian æra. That pottery was carried to great perfection among the ancient nations, is shown by the exquisite remains discovered in Egypt, Greece, Italy, and other classic countries. Specimens of Mexican pottery exist which have a considerable resemblance to the Egyptian.

1278. *It is probable that the ancient Britons were acquainted with this art*, from the vases of earthen-ware which have been found in barrows in different parts of the kingdom.

Abundant remains of beautiful red pottery, made by the Romans, are found in the vicinity of Bath, and other parts of England where they had settlements, as at Burslem, in Staffordshire, where it appears, from fragments dug up, a Roman pottery existed; but it does not appear that the Greeks or Romans employed a vitreous glaze, though this is common in Egyptian antiquities, and had been long known to the Chinese. In later times, earthen-ware with a painted glaze was largely employed by the Arabians in decorating mosques and other buildings, as well as for domestic purposes, and the art of fabricating it passed from them into Spain in the ninth century.

1279. *A manufacture of beautiful compact stone-ware was established at Fayenza, in Italy*, from which the French term *faience* seems to have come. The body of this was a red or a white clay, and the glaze was opaque, being formed of the oxydes of lead and tin along with potash and sand. The Venetians, Genoese, and Florentines bestowed much

pains upon this manufacture, and specimens of their early pottery are much prized by collectors: some of it is elegant in form, and admirably painted. It is said that Raphael in his youth, as well as other able artists, painted on earthen-ware, or at least gave designs for that purpose, and some is still distinguished by the name of *Raphael's china*, which sells for a very high price.

1280. *Bernhard de Pallissy*, a person of great ingenuity, about the middle of the sixteenth century, manufactured the first white *faience* at Saintes, in France, and not long afterward, the Dutch produced a similar article, of a substantial make, called, from the place where it was made, *Delft-ware*, but destitute of those graceful forms and paintings for which the ware of Fayenza was distinguished.

1281. *The Dutch probably derived their knowledge of this manufacture from the Venetians*, with whom they had extensive commercial dealings; but the blue colour which they employed in ornamenting it with Dutch subjects may have been imitated from the blue and white ware of Nankin, which they likewise imported. Delft-ware is a very coarse kind of pottery, and, from the coarseness of its texture, the potter was obliged to make it thick, clumsy, and heavy, in order to ensure its strength and durability. The glaze was made of common salt, sand ground fine, oxyde of lead, and oxyde of tin, the latter giving opacity to the glaze. It resisted the sudden application of heat, and was much employed, among other things, for tiles to line chimney fireplaces and stoves.

Before the manufacture of European porcelain, a great deal of the best earthen-ware used in this country was imported from Delft, or was made at Lambeth, where some Dutchmen had settled about two hundred years ago. But the use of Delft pottery was afterward superseded by the white stone-ware from Staffordshire, the latter being lighter and more durable. Delft-ware is now made only into tiles for lining dairies and baths, pomatum pots, a few jugs, and similar articles, and, instead of twenty manufactories of it, as formerly at Lambeth, it only partially employs one.

The vast improvement that has taken place of late in English pottery will be described under "English white stone-wares."

Sect. II.—Principles of Pottery.

1282. *Clay is the material which forms the basis of all kinds of pottery*, whether coarse or fine. Pottery may be divided into two principal kinds: *ordinary earthen-ware* of every kind, which is formed of clays that are infusible in a strong heat, and continue always opaque after having been fired in the furnace; and *porcelain*, which is composed of two sorts of earth, one infusible, and the other fusible, by which, when baked in the strong heat of a furnace, it becomes semi-vitrified and translucent.

1283. *Natural clays* are of various qualities; but those which are fit for the potter are rare. Clay consists of the earths alumina and silica mingled together.* Alumina readily unites with water, and forms with it a pulpy mass, which has a certain degree of tenacity and adhesiveness. Silica, on the contrary, when mixed with water, has no adhesive property. It is, therefore, the alumina in the natural clays that gives them the property of being plastic, or capable of being moulded into any form when in a moist state. Alumina is never found pure or separate in nature, although it can be procured by the chemist by detaching it from other substances; but this is not necessary for the purpose of the potter; the clay which he requires is a *natural* mixture of alumina and silica.

1284. *Clay, when made into a paste with water*, becomes harder by drying; but then it shrinks, and is apt to become full of cracks. The mixture of silica with the alumina corrects this fault, the silica having no tendency to crack. Clay, after having been properly worked up into various forms when in a moist state, and dried in the sun and air, so as to acquire a certain degree of hardness, may be softened again by being beat up with water, and thus brought back to its original state. But if such hardened clay be exposed to the heat of a strong fire, and baked or burned, as it is called, not only will its hardness be very much increased, but a great change will be found to have taken place in the nature of the substance, for it is no longer capable of being again reduced to a paste by water, and its fragments cannot be softened any more than those of stone.

1285. *These properties of clay were, no doubt, discovered by mankind in the earliest times.* We read in the Bible of bricks made in Egypt by mixing clay with straw. The latter substance was for the purpose of correcting the defect of clay alone in cracking by drying, for such bricks were merely dried and hardened by the heat of the sun; and we actually find such bricks at this day in Egypt, and also in the ruins of Babylon; but when vessels of clay are required to hold fluids, burning them in the fire is a necessary process.

1286. *For making pottery or earthen-ware*, the clay is beaten a good deal in water, by which the fine parts are suspended in the fluid, while the coarser sink to the bottom of

* We shall speak of silica as being simply an earth (the siliceous earth), which will be sufficient for a popular view of the subject; but this earth is now known to consist of the elementary principle silicon united to oxygen, and is sometimes termed by chemists silicic acid. The earth alumina consists likewise of the element aluminum united to oxygen.

the containing vessel. By pouring off almost instantly the water containing the finer particles, the coarse are left behind. If now this finer part of the clay be suffered to subside, and the water be poured off, a clay will be produced much finer than the first, and may be still farther depurated by passing through a fine sieve. This appears to have been the only process employed in making earthen-ware formerly. The best natural clays were sought for, and were purified in this manner. They were then moulded on the potter's wheel, and burned by a proper degree of heat.

1287. *Very good potter's clay, or a mixture of alumina and silica alone, is infusible in the heat of our furnaces*, and, as it becomes more and more hard by a greater degree of heat, by high and long-continued firing, to wares made of this material an extreme degree of hardness may be given, with the quality of being impenetrable to fluids. But such clays are extremely rare, and those which are employed for pottery are usually mixed naturally with a small quantity of lime, iron, and perhaps magnesia, and other substances. Much lime, and also oxyde of iron, in the clay causes it to fuse, and therefore prevents its being subjected to the same degree of heat as it otherwise might, and of receiving the same degree of hardness.

1288. *After the potter's clay has been well ground and kneaded, it is put upon the centre of the potter's wheel*, which is a circular board placed horizontally, and kept in constant rotatory motion; it is then, first by the workman's hand, and afterward by proper tools, formed into vessels of various shapes, which are dried, and, as soon as they can bear being removed, are baked in the potter's kiln or oven. After it is baked, it will still be more or less porous, and cannot yet be applied to the purpose of holding liquids. It is necessary, therefore, to cover it with some sort of glaze, which is usually of a vitreous kind.

Subsect. 1.—*Common Red Pottery and Stone-ware.*

1289. In every civilized country an earthen-ware is made of the finer varieties of the same clay of which bricks and tiles are made, but much better selected, and prepared in a clay mill; the red colour which it acquires on being burned, is owing to the oxyde of iron it contains.

1290. *Red pottery* includes the common red pans, pipkins, baking-dishes, and a variety of others in household economy. As this ware does not stand the heat of a fire, it cannot be used for many purposes of cookery, for which, in England, metal is almost universally employed. This coarse kind of pottery had been made in this country from time immemorial, being, in ancient times, chiefly manufactured at the place still called the Potteries, in Staffordshire, which is now celebrated for the variety of its earthen-ware of the best description. It is also manufactured in the vicinity of London, and in many other parts of the kingdom.

1291. *The materials of which the glaze is usually made* consist of litharge of lead or galena, which is a lead ore, ground up with clay. After the glaze is laid on, the vessels are again exposed to a high degree of heat, which causes the lead and the surface of the clay to vitrify, or run into glass. This thin coating of glass, being transparent, shows the red colour of the ware; if a black, opaque glaze be required, manganese is mixed with it.

1292. *There is a serious objection to this glaze made with so great a quantity of lead*, which is, that it is soluble in vinegar and the juice of most fruits, especially when hot, and also in boiling fat, which renders the use of vessels that are covered with it dangerous to health, if employed for holding food.

In some countries the use of such vessels in the process of boiling and stewing is forbidden by the laws, under severe penalties. In this country, those who understand this subject take care not to preserve pickles in earthen vessels glazed with mixtures containing much lead.

1293. *A great improvement was introduced at the Potteries in Staffordshire, in* 1690, by two brothers, named Ebers, from Nuremberg. They manufactured a new kind of fine earthen-ware of red clay, which they glazed without lead, and by the use of common salt alone. When the earthen-ware is in the kiln, salt is thrown in; and the fumes caused by this substance have the effect of producing a vitreous glaze on the surface of the ware. The mode in which this effect, so simple, is produced deserves explanation. The salt is thought to be decomposed by the heat into its constituents, muriatic acid and soda; the former flying off in dense white fumes, while the latter attaches itself to the sides of the ware, with the surface of which it forms a thin coating of actual glass (see "Glass making"); and this, being entirely impervious to liquids, answers the intended purpose. This glazing, besides, has the valuable property of being perfectly harmless. Notwithstanding the obvious advantages of this new glazing, however, in consequence of some jealousy among the neighbours, from the process being kept a secret, they obliged the strangers to leave the country; but not before the art had been learned by a workman of the name of Astbury, who had made himself acquainted with every part of the process, and who afterward practised it.

1294. *The common brown stone-ware* was probably the produce of the same period, hav-

ing been made in various countries of Europe ever since the fifteenth century. The manufacture of it was brought to us from Holland by some potters who settled at Lambeth. It has the valuable property of bearing, without injury, the heat of the fire, which is not the case with the red ware; and on this account it has long been employed in various countries for boiling liquids. Its power of resisting heat renders it useful even for chemical vessels; and Macquer says, that with respect to infusibility, it has all the qualities of the finest old Japanese porcelain. Its body is exceedingly dense and compact; and, when properly made and baked, it is sufficiently hard to strike fire with steel; it is composed of pipe clay, mixed with fine sand, and sometimes broken stone-ware ground to powder, in order to diminish the contraction of the clay in the fire. In the finer jugs, some calcined flint is added. The vessels, after having been formed by the potter's wheel, are fired in a kiln, and glazed by salt in the manner above described.

1295. *At present, stone-ware is made into* water-pitchers, soda-water bottles, and pipkins intended to stand the fire; also crucibles, retorts, and a variety of other chemical apparatus are made of a material nearly similar. The best kind is still made in the potteries at Lambeth, the proprietors of which procure some of their clay from Devonshire and Dorsetshire, and purchase flint ready ground from Staffordshire, where this material can be afforded at a cheaper rate than would attend its preparation near the metropolis. Jugs have often a light and a dark part in the glaze; the light is from salt alone, the dark has a mixture of some other glaze. The proportions of the ingredients are kept secret by the manufacturers; but the best materials are said to be a mixture of pounded Hessian crucibles and Stourbridge clay.

Metallic vessels are so generally used in England for boiling and stewing, that the want of an earthen-ware manufacture to answer this end is little felt; but it would be desirable that a cheap article of this kind for culinary purposes should be got up, since earthen-ware is preferable to metal for stewing; and on the Continent it is the general practice to stew in earthen-ware.

It is said that the *grey Dutch stone-ware* is superior to the English in strength, and particularly in bearing exposure to the fire. Some of the original Dutch stone-ware jugs, brought into England before they were made here, it is stated, may sometimes be met with in the eastern parts of London.

SUBSECT. 2.—*English White Stone-ware and Wedgwood's Wares.*

1296. *To Astbury, already mentioned, is ascribed* a great improvement in pottery, the introduction of flints, calcined and ground, as a material to be mixed with the clay, from which a much better white earthen-ware was made. It is said that accident led to this discovery. While travelling to London on horseback, in 1720, Astbury had occasion, at Dunstable, to seek a remedy for a disorder in his horse's eye; when the ostler at the inn, burning a flint, reduced it by pounding to a fine white powder, which he blew into the diseased eye to effect a cure. The potter, observing the beautifully white colour of the flint after calcination, instantly conceived the use to which it might be applied in his art, by mixing it in his clay, and thus made the first white stone-ware.

1297. *The improvements we have mentioned paved the way for some of still greater importance by Mr. Josiah Wedgwood,* who was the younger son of a Staffordshire potter, and born in 1730. This extraordinary man, overcoming the difficulties of his early life, by indefatigable industry and perseverance, and applying himself to a great variety of improvements in pottery, not only succeeded in acquiring an ample fortune, but became even a considerable benefactor to his country, by carrying the art of pottery to a high degree of perfection, and creating a commerce which, to this day, proves a source of national wealth. But the merit of Wedgwood did not consist merely in having the sagacity to perceive that a profitable business could be formed by improvements in his art. His mind was of a higher class. Not only devoting himself to patient investigations, he gathered round him the talents of various countries, and by the liberality of his conduct towards the individuals whom he engaged, he encouraged them to give him the most effective assistance in prosecuting and completing those views which his genius imagined, but which he could never have accomplished alone. He engaged Mr. Chisholme, an able chemist, to apply himself solely to those pursuits and experiments which were necessary for the selection of the best materials, and for perfecting his various processes; and he liberally provided for him when old age incapacitated him for farther exertions. Not satisfied with improving the materials of pottery, he was desirous of giving greater value to it, also, by improvements in form. Assisted by the classic taste of his partner, Mr. Bentley, the ablest modellers were brought from Italy and other countries, who were intimately acquainted with the works of the ancients, and he rewarded the services of these with liberal encouragement. The consequence of this was, that English pottery, hitherto unknown as a class, became celebrated and eagerly sought for throughout the civilized world. We cannot help repeating, that it was to the enlightened and liberal views of Wedgwood that his success was mainly owing; nor should it be forgotten that the ample fortune he thus acquired was generously expended in promoting the spread of knowledge, in encouraging the efforts of genius in others,

and in lessening, as far as lay in his power, the sufferings of his fellow-creatures. The disposition and manners of Wedgwood were no less estimable than the powers of his mind, so that he became the object of admiration and esteem for his moral as for his intellectual qualities. He died in the sixty-fifth year of his age.

The interest that must always be taken in the pottery produced by Wedgwood demands that we enumerate the various kinds. In 1763, Wedgwood manufactured a kind of ware for the table, of a cream colour, which came into universal use in this country, under the name of *queen's ware*, which was conferred upon it in consequence of the patronage of her majesty. The materials were the whitest clays from Devonshire and Dorsetshire, mixed with ground flints, and covered with a vitreous glaze. This ware, being executed with care and expedition, was sold at a cheap rate, and was superior to any that had hitherto appeared for ordinary purposes. By varying his experiments and the proportions of his materials, Mr. Wedgwood discovered the mode of manufacturing other species of earthen-ware, which were excellent and beautiful, and adapted to various purposes of use and ornament.

1298. *The ware known in general by the name of Wedgwood's* is a kind of semi-vitrified pottery, which is not susceptible of receiving a strong superficial glaze, but which can receive all kinds of colours by means of metallic oxydes and ochres. The pastes of which they are formed are extremely plastic, and may be worked and moulded with the greatest facility. The more delicate ornaments are cast in moulds and stuck on; they are applied with remarkable dexterity by women and children. It is of the following varieties:

A Bamboo or cane-coloured biscuit was one of Wedgwood's original wares, and was employed for many elegant articles for the table: it is extremely compact, and was not glazed. It is still in use, and is sometimes slightly glazed.

A white biscuit was also made, having the chief qualities of porcelain, but without its transparency.

An extremely hard porcelanous ware was likewise made and employed for chemical vessels, as evaporating basins, crucibles, mortars, tubes, and other apparatus: this, from its resisting the corrosion of the strongest acids, and not fusing with the strongest heats, has been an invaluable acquisition to the chemist. These are composed of six parts of potters' clay, three of granite, two of calcined flints, and one of Cornish or China clay.

Wedgwood's black Egyptian ware was for a long time very extensively used for the tea-table, owing, in a great measure, to the elegance of its forms and decorations, which rivalled in design the works of Greek and Roman artists. When this novel kind of ware was produced porcelain had not been made in England, all that was then used being foreign, which was for a time almost entirely superseded by the various beautiful wares of Wedgwood. Its black colour was given by manganese. Besides tea-pots, sugar-basins, and milk-pots, a variety of ornamental articles were made of it, such as inkstands, vases, lamps, &c., which were ornamented with elegant bas-reliefs, figures, foliage, and other devices, which were sometimes in a dark red colour. This kind of ware is still executed by several potters, but it is lamentable to perceive the falling off in the taste of the forms and designs since the death of Wedgwood. It is owing to this, and the introduction of English porcelain and other wares, that the black Wedgwood articles have nearly gone out of use, being purchased now merely for their cheapness. Originally they were not glazed, by which the perfect effect of the beautiful ornaments was seen; but this had the inconvenience of being somewhat difficult to keep clean. At present it is generally covered with a slight glaze, which permits its being washed and kept clean with perfect facility, though the effect of the ornaments is much diminished. To produce the slight glaze given to it, technically termed *smearing*, the ware is not dipped into a liquid glaze, but placed in the seggar in the state of biscuit; and the insides of the seggars being coated with salt, or some volatile glaze, these are converted into vapour, which vitrifies the external part of the ware, and gives it the desired lustre.

Wedgwood made, likewise, what he called the *jasper-ware*, which had elegant bas-reliefs on a beautiful blue ground. The white vitrifying pastes used in the jasper-ware is composed of forty-seven parts of sulphate of baryta, twenty-six potters' clay, fifteen of calcined flints, fifteen of granite, six sulphate of lime, and ten sulphate of strontium: the baryta serves as a flux to the clays. The fine Wedgwood blue on this ware is produced by cobalt. The delicate white ornaments are cast in moulds and stuck on. From this jasper-ware, which found its way into every country in Europe, he derived great profit, until, by the infidelity of a servant, the secret was disclosed and sold, so that others executed the same art; and though by means of inferior artists, yet this interfered so much, that it prevented Wedgwood from keeping up the price and employing the same talent as before.

Excellent imitations of Etruscan and other antique vases were executed by Messrs. Wedgwood and Bentley. It does not appear that the Greeks or Romans were in possession of a complete vitrified glaze for their pottery; but the vessels mentioned as

having been made in the island of Samos had a red covering that was probably imperfectly vitrified, as they were held in high estimation for cooking. Earthen jars for holding dry substances were not glazed, but were similar to those now brought from Spain and Portugal with grapes. When they were employed as amphoræ for holding wine, they were rubbed over with wax to stop their pores. The vases found in such numbers in Greece and Italy, and commonly called Etruscan, were in part coloured by a black covering that is carbonaceous and not vitreous, which wears off by use. The exact nature of this black varnish has never yet been determined with certainty; but the vases themselves are exquisitely beautiful in form, and ornamented with infinite taste.

Among the ornamental works executed by Wedgwood may be reckoned two imitations of cameos: one of a slave in chains, of which he distributed many hundreds, to induce the suppression of the slave-trade; and the other representing Hope, attended by Peace, Art, and Labour, made of clay from Australia, to show what is produced there. One of the most splendid works of this kind was an imitation of the celebrated Barbarini or Portland vase, which was discovered in the tomb of Alexander Severus, and which was purchased by the Duchess of Portland. This copy was modelled by Mr. Webber, and fifty vases were made, for which 50*l.* each were subscribed, a sum which did not nearly defray the expense.

Various imitations of antique cameos were executed in great abundance and variety, many of which were white, upon a deep blue ground; and others resembled agates, jasper, and other stones. The modelling of many of them do infinite credit to the artists who executed them; and it is highly to be regretted that no works of the same merit now come from our potteries. After Mr. Wedgwood's decease, his establishment in London was given up, and his stock was sold, part of which was purchased by Mr. Phillips, and a remnant is now to be seen in his warehouse in Oxford-street.

1299. *Of Wedgwood's manufacture, it was said by the celebrated Faujas Saint-Fond,* "Its excellent workmanship, its solidity, the advantage which it possesses of standing the action of the fire, its fine glaze impenetrable to acids, the beauty, convenience, and variety of its forms, and its moderate price have created a commerce so active and so universal, that in travelling from Paris to Petersburg, from Amsterdam to the farthest point of Sweden, and from Dunkirk to the southern extremity of France, one is served at every inn upon English stone-ware. The same fine article adorns the tables of Spain, Portugal, and Italy; it provides the cargoes of ships in the East Indies, the West Indies, and America."

1300. *The usual processes by which the various kinds of pottery called white stone-ware, or Staffordshire ware, are manufactured,* are the following: the body of the ware is formed of a fine pipe or potter's clay mixed with calcined flints, and sometimes a little porcelain clay. The clay consists of 76 parts of silica and 24 parts of alumina; it is very refractory in strong heats, and burns very white in the fire: properties which render it extremely valuable for pottery. The best clay is found in Dorsetshire; an inferior kind is procured in Devonshire. This clay is beat up with water, and then passed through fine sieves to separate all the coarse particles. The flints are burned in kilns, and while hot are quenched in cold water, by which they are cracked through and through in innumerable places; after this they are ground in mills to the consistence of cream. The porcelain clay consists of decomposed feldspar, and, being entirely procured in Cornwall, is called *Cornish clay*. The proportions of these materials are varied according to the particular kind of ware, or the skill and experience of the manufacturer, and each has generally some mode of his own, which he keeps secret. They are mixed by measure, and put into troughs to be reduced by evaporation to a proper consistence for moulding. When tempered in a pug mill, and brought into a plastic state, like a kind of dough, the clay is formed on the potter's wheel into plates, cups, saucers, basins, and all the various articles usually made. When these are half dried, they are finished by turning in a lathe. Handles, spouts, bas-reliefs, and such parts, are made separately in moulds, and stuck on while the clay is soft by dipping them in some of the liquid clay. Plates are made by a mould, into which is pressed clay rolled out, and are finished by turning the mould round. When the forms are complete, they are dried, and the whole is placed in large cases made of burned clay, called *saggars*, and burned in the kiln to the state called biscuit, which has no gloss, and resembles in colour an egg-shell: it has the property of strongly imbibing moisture. The burning in kilns demands a great deal of fuel, and the abundance of this in Staffordshire is the chief reason why the potteries are established there; but another is the facility of transporting the materials and manufactures by canals. A great deal of care is necessary in piling up the biscuit previous to burning; and the management of the fire is of great consequence. The baking usually lasts from forty to forty-two hours, and the ware is suffered to cool very slowly. The ware is now to be coloured or painted. Some of this is performed by hand with hair pencils; but the principal part of the ornament is often produced by the following process: the pattern is engraved on a copper plate, and an impression is taken on thin unsized paper made on purpose, and previously immersed in strong soap water; this is applied in its moist state to the surface of the biscuit, which is of a very absorbent or

adhesive quality; the paper is then rubbed or pressed down by means of a roll of flannel. Afterward the ware is dipped in water, and the paper is easily removed, leaving the impressions upon the surface; and after this the piece is dipped into a caustic alkaline lye, to saponify the oil before the glaze is applied.

The pigment with which the lines of the engraved copper-plate are filled up depends upon the colour intended. The colour that has been most generally used is a pale blue, like that of the Chinese porcelain, which has a remarkable elegance and softness: this colour is a compound of arseniate of cobalt, ground up in boiled linseed oil, and mixed with a proper flux. It is made darker or lighter, according to the quantity of cobalt used. In some cases, where the engraved pattern is smaller than the surface to be covered, a very ingenious mode is employed. The impressions are taken upon an elastic substance, a composition of glue and treacle, or upon India rubber, which, being stretched to the due size, are applied to the biscuit.

When the pieces thus painted have stood long enough to dry, they are placed in a gentle heat in an oven, in order, by dissipating the oil that was used with the colour, to prepare the ware for receiving the glaze. This is transparent, as otherwise the distinctness of the pattern would be impaired.

The substances employed for the glaze are ground to impalpable powders, in water, to the consistence of cream, and the biscuit-ware, now coloured, is dipped into this, called *slip*, and enough adheres to form a vitrified covering, when the ware is again put into an oven called the *gloss oven*, which finishes the baking.

1301. *A variety of glazes are employed by* different manufacturers; a good glaze or enamel is essential to the beauty of earthen-ware and porcelain: it should experience the same degree of expansion and contraction, in consequence of the change of temperature, as the biscuit which it covers, otherwise it will crack in all directions, which happens to imperfect glazes, or to earthen-ware where the body and glaze are not suitable to each other.

Silica alone cannot be fused in the most powerful furnace, and therefore cannot be employed for a glaze; but when an alkali or lime is added to it, it is vitrifiable by a very strong heat. This mixture is the glaze used in true porcelain; but the ordinary earthen-ware cannot bear the heat that would be necessary for it, and therefore one more fusible must be resorted to. Silica, combined with oxyde of lead, is easily converted into a glass fit for glazing earthen-ware, and this, being convenient for the potter, has been generally used. But this glaze we have already stated to be objectionable, since, when the quantity of lead is considerable, there is great danger of its being dissolved by substances used as food, and the deleterious effects of lead are well known. The application of such glazes has likewise injurious effects upon the health of the workmen, who are frequently seized with paralysis.

The best glazing for common earthen-ware vessels that are to be used in preserving and preparing food is undoubtedly that which has been described as produced by salt, though this glazing has not a high lustre; but it is very hard and durable, never cracks, is insoluble in all kinds of acids, and is not, in the smallest degree, unwholesome. It has long been a desideratum to discover some glaze which has all the advantages of that where lead is employed, without its poisonous qualities; and other glazes have been invented, but they are not yet employed universally in our pottery.

The glaze for common cream-coloured, or queen's ware, is composed of 53 parts white-lead, 36 of ground flints, 16 feldspar, and 4 of flint glass. Some use white-lead, ground flints, and common salt. The quantity of lead employed here is considered too small to be injurious to health, particularly as it is so locked up in the glaze; but some manufacturers employ a glaze that has no lead, as white glass and soda. Mr. Rose, in Coalport, Shropshire, makes his glaze of 27 parts feldspar, 18 of borax, 4 of Lynn sand, 3 of nitre, 3 of soda, and 3 of Cornish China clay.

Before the invention of this method of applying designs to earthen-ware, table services of English pottery were composed of plain queen's ware, sometimes with a coloured edge, and occasionally with a painted border, done by hand, and which was executed in a slovenly manner. But the mode of transferring prints to earthen-ware gives such a facility in decorating it that it has completely changed the aspect of our pottery, and contributed greatly to extend our trade in earthen-ware over the continent of Europe.

1302. *The blue printed ware of England cannot yet be manufactured in France*, according to the report of M. Brongniart, director of the porcelain manufacture at Sèvres. It appears that the extent of our potteries in Staffordshire, and the abundance of fuel, enables us to prepare the calcined flints at a cheaper rate than the French can; consequently, they employ chiefly pipe-clay, which, alone, is a very inferior material; and the English artisans have more dexterity, from their vast practice. The French, indeed, admit that our ware of this kind is unrivalled for strength, lightness, and elegance, the delicate blue printing equalling the colouring of the Chinese; and this the French fail in attempting.

SUBSECT. 3.—*Some other Kinds of Earthen-ware made in England.*

1303. *The wares called lustres* have a metallic appearance, and would be highly prized if they were not so cheap and common. There are gold and copper lustres; also platina lustres of two kinds, one which imitates polished steel, and another that approaches to the colour of silver. The latter are made by dissolving the platina in aqua regia, and mixing this solution with balsam of sulphur; this compound is diluted with turpentine and laid on the ware, which is then placed in an oven, where the metals are revived in their metallic state, and they are then covered with a glaze, which effectually protects them. An iron lustre is also sometimes made, but it is inferior to the platina. An aventurine glaze may be given by grinding some silver leaf with the above glaze.

1304. *A kind of pale red or flesh-coloured earthen-ware*, not glazed, is made at Lambeth from clay found at Maidstone, and is much used for ornamental vases, stoves, and ornamented chimney-pots, &c.

1305. *Lately a manufactory of terra cotta* of flower-vases, garden pots, &c., of a superior kind has been established at Lowestoffe, in Leicestershire, from clay found on the estate of Sir Frederic Fowke. Some of these are made of classical shapes; others are of English design. They are not affected by frost or rain, and are certainly a great improvement on the common forms of garden pots; they are employed in ornamenting balconies, conservatories, &c. The clay bakes to an agreeable red, and some of the articles are embossed; others are painted or coloured in imitation of the Etruscan. Specimens of this manufacture are to be seen in the Pantheon Bazar, London.

1306. *Rockingham ware* is a coarse strong ware, lately introduced, capable of standing the fire, and resisting changes of temperature. It is covered with a dark brown glaze, and is employed for tea-pots, and various vessels liable to be exposed to heat and cold. It is manufactured at Rotherham, in Yorkshire, and derives its name from the Marquis of Rockingham.

1307. *Tobacco-pipes of the common white kind* are made of best potter's clay, such as that found in Dorsetshire, hence called pipe-clay, which burns perfectly white. After the clay has been formed into a ductile paste, it is rolled out into portions the length of a pipe, and perforated with a brass wire rubbed over with oil. The heads are made in a mould, and fixed on to the tube. The pipes are then dried, and are piled in furnaces built for the purpose, where they are baked. The Dutch pipes are glazed with a varnish made of soap, white wax, and gum arabic, which is rubbed on with a cloth. These pipes, as is well known, are capable of sustaining a red heat without injury. Some tobacco-pipes are made of red clay, and others of meerschaum, which are imported.

1308. *The produce of the English potteries* have found their way into every part of the civilized world; and it is a remarkable fact, that they have even penetrated into countries to which our most enterprising travellers have scarcely had access. Captain Clapperton, in the account of his journey into the interior of Africa, states that, when on a visit to the court of Sultan Bello, "provisions were regularly sent me from the sultan's table on pewter dishes with the London stamp; and I even had a piece of meat served up on a white wash-hand basin of English manufacture."

It is estimated that the value of the various sorts of earthen-ware produced at the potteries may amount to about £1,500,000 a year, and that the earthen-ware made at Worcester, Derby, and other parts of the country, may amount to £750,000 more, making the whole of the manufacture £2,250,000 or £2,350,000 a year. The consumption of gold for gilding, &c., at the potteries is about £650 a week, and of coal about 800 tons per week.

SECT. III.—PORCELAIN.

SUBSECT. 1.—*Historical Remarks*

1309. *Porcelain is the most perfect production of the potter's art, and had its origin* among that extraordinary people the Chinese, who were in possession of the art of fabricating this beautiful ware before the Christian era; and a coarser kind of it was made also by the Egyptians. Vessels of porcelain occasionally found their way into ancient Rome in the first century, probably from China or Japan, a certain quantity of trade having been carried on then, as now, between nations very distant from each other by means of caravans. It appears that the Portuguese, in trading with China, were the first to bring porcelain into Europe in considerable quantities; and they gave to it its present name, it is said, from the resemblance of its glaze to the natural polish of a shell called by them *porcella*. The Chinese name is *tse-ki*.

1310. *Dr. Anderson, in his History of Commerce, says that the first porcelain brought to London was in a Portuguese ship taken as a prize in* 1593. Its beauty soon caused it to be in great request among the great and wealthy; and the emulation of European artists to imitate it was soon excited. Of the various attempts made in different parts of Europe, the most successful was at Dresden; afterward, some Jesuit missionaries who were permitted to penetrate into the interior of China, learned something of the manufacture there. They contrived to procure specimens of the materials, and trans-

mitted them to Europe, with some account of the processes employed. These materials were analyzed by Reaumur and other chemists, and it was soon discovered that the same substances existed in France, and in many other parts of Europe. In consequence of this, several European sovereigns, anxious to possess manufactories of so beautiful a ware, formed establishments for that purpose. That of Dresden was the first to make porcelain like the Chinese, and it has ever since been famous for the beauty of its productions. A magnificent establishment was likewise formed at Sèvres by the French government, and others in Vienna, Berlin, Bohemia, and several even of the smaller states in Germany.

SUBSECT. 2.—*Distinctions of Porcelain, and Manufacture of English China.*

1311. *Two materials are necessary to form the true porcelain of the Chinese:* one is named by them *Kaolin*, and is our porcelain or China clay, which results from the decomposition of feldspar; the other is called *Petunze*, and consists of fresh or undecomposed feldspar ground very fine. Feldspar in the latter state contains some potash, and is a substance fusible in a considerable heat; but when the feldspar has lost this ingredient in consequence of being decomposed by the weather, it falls into an earthy powder, constituting the kaolin, and is then extremely refractory, not fusing in our powerful furnaces. By the union of two substances, one very infusible, the other fusible to a certain degree, the body of the porcelain-ware is made: if the kaolin alone was used, the ware would have no transparency. The Chinese, likewise, occasionally employ another material instead of the kaolin, which they call *hoaché*, and which answers to our soapstone, or perhaps agalmatolite. These materials being prepared with the greatest care, are formed into paste with water, moulded on the wheel, or cast in moulds, and the vessels so formed are exposed to a strong heat in a kiln, which produces the semi-vitrified appearance which real porcelain always has.

1312. *One of the chief properties of true porcelain* is the great difficulty with which it is melted, being quite infusible in our ordinary furnaces; on which account, it is frequently employed in chemical experiments, to contain substances that are to be exposed to a degree of heat sufficient to fuse all metallic vessels except those of platina. Other properties are, whiteness and semi-transparency, owing to the commencement only of vitrification in the process of baking; and this latter quality is very often considered, though incorrectly, as the distinguishing character of this ware, vulgarly termed *china*. But it is possible to obtain the whiteness and transparency of true porcelain in fabrics of the potter, without its infusibility and hardness; for if a species of pottery that is very fusible be exposed to a heat just sufficient to bring it to the commencement of vitrification, and then the fire be withdrawn, the transparency and appearance of porcelain will be produced; but such ware will vitrify by a degree of heat only a little higher than that by which it was made; yet articles manufactured in this manner are often called porcelain or china, and sold as such.

1313. *From this account, there are two kinds of ware which receive the name of porcelain*, and yet are essentially different; a circumstance that gives rise to very erroneous ideas on the subject.

1314. *The genuine or true porcelain*, like the Chinese, is called by the Continental potters the *hard porcelain;* and is, as we have stated above, made entirely of kaolin or China clay, and petunze or undecomposed feldspar ground to a fine powder; and the glaze of this is likewise feldspar alone, vitrified in the kiln.

1315. *The false porcelain*, called the *soft or tender porcelain*, is made of a vitrifiable frit, composed of various ingredients, such as fine pipe clay, calcined flints, bone ashes, with, perhaps, some China clay, and barilla, alum, &c., according to the particular practice and experience of the manufacturer. The glaze of this latter kind is merely a kind of glass prepared on purpose, and made of siliceous sand, or flints, alkali, and oxyde of lead; and is much softer and more easily scratched than the glaze of the true porcelain composed of vitrified feldspar. This soft porcelain, likewise, is not only fusible in a heat not very considerable, and therefore incapable of being applied to the same uses as genuine porcelain, but it cannot resist the rapid changes of temperature like true porcelain, soon becoming covered with cracks even by the heat of boiling water; it is generally more transparent than true porcelain, and, having some advantages in the processes of painting, is made so gay in its decorations that it easily imposes upon the inexperienced eye. It is this soft kind of porcelain that is mostly made in the English potteries, where it appears that comparatively very little true porcelain is manufactured. It was also the soft porcelain that was made in the manufactories established, many years ago, at Bow and at Chelsea, where a great deal was formerly produced in imitation of the Dresden china. At that time the true materials for porcelain, the China clay, which was employed in the Continental potteries, was not known to exist in England.

1316. *The first true porcelain made in this country* was by Mr. Cookworthy, who, in 1768, discovered that Cornwall contained the earths necessary for that purpose; but although he had a patent for the exclusive right of using them, and succeeded tolerably

well in the quality of his ware, which was confined to an imitation of the Chinese, the demand was not equal to the expense; owing, in a great measure, to the circumstance of Mr. Wedgwood having excited so much interest by the invention of several new kinds of pottery, foreign porcelain, or its imitations, became less an object of desire.

1317. *Of late years, however, by the employment of the only true materials*, together with great improvement in the painting, English porcelain has been made occasionally that scarcely yields to that of any other country. It is important to observe that there is a considerable difference in the quality of what is manufactured, owing to the various ingredients used. In the best English porcelain, the China clay from Cornwall is employed, and also the soap rock from the Lizard, together with petunze, or ground compact feldspar; but in several manufactories they content themselves with mixing with this a considerable proportion of pipe clay, calcined flints, and bone ashes, with, perhaps, a little alkali, to assist the commencement of fusion, and give the semi-transparency. As each manufacturer keeps secret the nature and proportions of the materials he employs, each person having some particular composition which he considers superior to every other, it is not easy to speak decidedly with respect to the complete practice in our potteries. The manufacturers of porcelain in France are less reserved; and we have published descriptions of their processes. Generally five tenths of the whole mass consists of kaolin, which they procure from Limoges. Some employ also a certain proportion of sulphate of baryta, and other substances. Private manufacturers of porcelain in Paris, of which there are many, avoid the trouble of preparing the materials by purchasing them in a state of readiness from establishments at Limoges, where the porcelain earth is found; and the price of the prepared material costs, in Paris, only three sous per pound, which gives them a great advantage over our potters.

1318. *The leading principles observed in the usual processes for making porcelain* in this country do not differ essentially from what we have already described when treating of the Staffordshire ware. The materials are very finely ground, mixed separately with water, to the consistence of cream, and then joined in the proper proportion. This is exposed to heat and evaporation, and made into a paste that is, when properly tempered, formed into circular vessels on the wheel, technically called "throwing;" and the facility with which the potter, by means of his wheel, forms the plastic clay into vessels of various shapes, by using merely his hands, excites the admiration of visiters. A great deal of care is bestowed upon the finishing the raw porcelain in the lathe after coming from the wheel, and likewise in putting on handles, spouts, and raised ornaments. The pieces are then carefully dried, and are now ready for the firing. For this they are placed in deep boxes, made of baked fire clay, called seggars, which admit the heat of the furnace, but protect the ware against any accidents. The process of baking generally lasts about from forty-eight to fifty hours, and great attention is paid to the degree of heat by placing in the kiln trial-pieces made of clay. These are taken out from time to time, to ascertain whether the ware is baked enough. The porcelain is now white, and in the state of *biscuit*, which is very like white sugar. In many cases the process stops here; and in this way are made those exquisitely delicate pieces of fruit, flowers, and other ornamental works of white biscuit for which the Derby works are so famous. All the soft porcelain, as well as common earthen-ware, is so porous in this state as to be permeable to water, and, consequently, a vitreous glaze is necessary to fill up the pores when vessels are made. The glazes for soft porcelain are, as we have stated, mixtures of some earthy substance, such as flint or clay, or both combined, together with some vitriable metallic oxyde, in order to give the necessary fusibility. The oxyde of lead is generally employed for this purpose, with some addition of oxyde of tin or arsenic, to produce a certain degree of opacity. In the best hard porcelain, such as that of China, Dresden, or Sèvres, the glaze does not contain lead or any metallic oxyde, but consists of undecomposed feldspar alone, ground to a fine powder, which is fusible in an intense heat, from the potash which it contains naturally. Pure undecomposed feldspar fit for the glaze of porcelain is rare in England, though abundant in some parts of the world. As it is the potash which is supposed to communicate to feldspar its fusible property, it might be thought that this alkali added to any earth, as calcined flint or pipe clay, would produce a perfectly good glaze; but, although these materials will form a glaze that is sometimes employed, yet such glazes crack all over, particularly when hot water is applied. The oxyde of lead forms a glaze that is not liable to this objection, but it is to another, that of making a glaze so soft as to be easily detached. The porcelain, after having been dipped in the material for glazing, is now subjected to a second firing, being placed, as before, in seggars; and the heat employed is that which is just sufficient to melt the glaze and cause it to vitrify. It is then ready for the painting and gilding. The different colours are produced by metallic oxydes, which are bodies that in general are capable of assuming a vitreous form with various degrees of facility; but they require to be accompanied by a certain vehicle, called a *flux*, which has the effect of rendering the whole more fusible than the first, or proper glazing, already described. This flux varies according to circumstances, but oxyde of lead, borax, ground glass, and nitre are substances employed. The

colours are mixed up with oil of lavender in laying them on. The manner of painting the best porcelain with a variety of colours is much the same as painting in enamel; and frequently the work is highly finished like miniatures. When the painting is finished, the oil evaporates, and leaves the colours dry and ready to be burned in by a third firing in the enamel kiln, which fixes and brings out the colour by the fusion of the vitreous colouring matter. Very great skill is required where many colours are employed; but in ordinary china the colours on one piece are but few. It frequently happens that a piece of porcelain has to go into the enamel kiln four or five times when a great variety of colours are contained in the painting.

1319. *Of late the use of this porcelain has been much extended*, and a great variety of articles are made of it, as fancy baskets, door handles, finger plates, candlesticks, ink and taper stands, &c.

1320. *Gilding on porcelain or glass is performed* by applying the gold in a metallic state, either as leaf gold, or in the state of a powder. It is made to adhere to the surface of the ware, either by exposing it to such a degree of heat as to cause an incipient fusion of the glaze on which it is laid, or by mixing with the gold some substance as a flux, the melting of which occasions its adherence. The powder of gold is sometimes made mechanically by grinding gold leaf with honey, which is afterward washed away; or it may be made by precipitating gold from its solution in aqua regia. This powder is then diluted with gum-water, either with or without a fluxing material, and the ware is exposed to the necessary heat in the oven. After the gold has been *burned in*, it is burnished with agates, an operation which is usually, in manufactories, performed by female hands. There is a great difference in the gilding of porcelain: some of the cheap kind sold is gilt in a very imperfect manner, by putting on the gold with japanners' gold size, and exposing it to heat; but this kind of gilding soon comes off by washing in hot water, whereas what is properly burned in never wears off.

1321. *Painting on porcelain is known as an occupation for ladies* who draw or paint on paper; and proprietors of potteries are accustomed to supply vases and other ornamental objects, in the state of biscuit, to such as wish to exercise their taste and ingenuity in embellishing them by painting and gilding. The pieces being then returned to the manufacturer, the glaze is applied, the baking is finished in the glass oven, and the gilding is burnished.

Subsect. 3.—*Porcelain of various Countries.*

322. *The chief excellence of Chinese porcelain* is the perfection of the ware itself, and its great infusibility and lightness. With respect to the painting, though the colours are often bright, yet the drawing is generally very rude. Among this extraordinary people the arts of design appear scarcely to have advanced far beyond their infant state; and it is remarkable that, with so much practice, the knowledge of drawing seems to have remained nearly stationary for ages. It is said that the Chinese themselves consider that the porcelain-ware made by their ancestors was superior in quality to any more recently manufactured, although this is doubted by some. For many ages they used only white porcelain, and the white colour was extremely brilliant. A very rich and deep blue was the first colour they employed, which, some say, was made from *lapis lazuli*; others think it was from cobalt. The fine blue porcelain-ware of China is highly valued by the curious; but now, it is said, they prepare this colour from English smalt, though inferior. There are also many other colours made from iron and copper. Black porcelain, ornamented with gold, known under the name of *usiam*, is much esteemed in the East. The principal porcelain manufactures are carried on at *King-te-ching*, in the province of Kiang-si, where they have been established for ages. It is said that there are 500 factories, employing a million of hands; these are walled round, and no strangers can have access to the works, so that, in fact, little is known respecting the details of their processes. It is stated that they keep their clay for a number of years before it is used, and that they will lay up a stock of it early in life for the use of their sons. Very large vases and other pieces of great magnitude are made by them; but the emperor monopolizes the finest specimens; and the best kinds, even in that country, are scarce, and fetch high prices. Porcelain is also made at Nankin, and a few other places in China, but it is thought to be inferior to that of King-te-ching. The Chinese evidently excel in the use of the potter's wheel, as may be seen by the extreme thinness of some of their cups and saucers; and the principle of the division of labour is by them carried to such an extent that a great many persons are employed on one tea-cup, each workman performing one operation, in which, by constant repetition, he becomes extremely expert. It appears that the processes of the Chinese differ in several respects from ours.

Their material is so infusible that they can apply a glaze which requires a much higher degree of heat to vitrify than any of our European porcelains, and which is much harder and less liable to crack. In our modern porcelain, in general, the body of the ware being more fusible than the Chinese, we cannot easily apply a sufficient degree of heat to fuse a glaze except it contain some lead or alkali, because the heat required

would melt the body of the ware. But we have stated that the use of lead is prejudicial to health, and the employment of alkali causes the glaze to come into innumerable cracks. Hence, not only our porcelain itself, but likewise the glaze, are usually inferior to the best Chinese. It is said, also, that their ware is merely dried in the air before glazing, as their composition so effectually resists water that it can be immersed in an aqueous glaze, without being first made into biscuit, and, consequently, they are enabled to burn their porcelain by a single firing The glaze of Chinese porcelain is so hard that it cannot be operated upon by any of our common instruments, whereas our glazes become scratched and defaced by ordinary wear.

1323. *Mr. Nicholson mentions a very simple method of ascertaining when the glaze of china is too soft.* This consists in dropping a small quantity of strong ink upon it, drying it before the fire, and then washing. If the glaze be too soft, an indelible brown stain will remain upon it. It has been remarked that the heat of the Chinese furnaces must be tremendous, far exceeding what we employ for the same purpose. Parke states that the calcined bones lately introduced as a material into some English porcelain acts much to the injury of the ware, which is thus very apt to crack with hot water.

It must be admitted, however, that, although difficult as it may be for the manufacturers of porcelain of this country to come up to Chinese porcelain in some qualities, yet we excel it far in the paintings with which it is ornamented; and we have stated the comparative merits of both, not with a view to undervalue our own produce, but, by placing the subject in the just point of view, to stimulate our native talent.

1324. *There are a great many varieties of Chinese porcelain*, and the passion for collecting these, and all kinds of articles from China and Japan, is not so prevalent as formerly, when the contents of a china closet were the subject of such amusement and admiration; but it is not altogether obsolete; and though it has been much ridiculed for the dragons, nodding mandarins, vases, fans, and tea-pots brought together, yet the collecting fine specimens of beautiful or ancient porcelain is by no means an absurd or inelegant amusement. The history of domestic customs is extremely interesting, and is illustrated by such specimens of art. It is, however, essential that very great care should be taken in distinguishing what is really ancient from modern imitations; for it is well known that when this kind of collecting was the rage, vast numbers of articles were made here, and on the Continent, to imitate Chinese; and these are frequently sold as such in the present day. Those who are good judges of real china-ware will detect the counterfeit chiefly by the style of painting, that of China and Japan being quite peculiar, both in the drawing and colouring.

1325. *The Dresden porcelain manufactory* was established at Miessen, near Dresden, by Augustus, elector of Saxony, in the early part of the seventeenth century. It was the first to succeed in making porcelain of a compactness and infusibility equal, according to Macquer, to the best of the Chinese. It has produced, besides the usual tea equipages, an immense number of figures of all kinds modelled in white biscuit, as well as glazed porcelain; and it was the source from which multitudes of chimney and other ornaments were for a long time supplied, which were less excellent for their design than for the perfection of the material and the brilliancy of the painting and gilding. The royal collection of porcelain at Dresden is thus described by a late tourist: "We have just returned from an interesting exhibition — the collection of porcelain in the Japanese palace. There are eight rooms full of china, of every age and from every country, chronologically arranged, from the first bowl of rough unglazed porcelain that ever was made by the alchemist Botiger, who discovered the manufacture, and who died in 1719, down, through various gradations of excellence, to the splendid vase fresh from the fabric of Meissen. There are specimens of Sèvres porcelain, a present from Napoleon, and some genuine Wedgwoods from England, besides a few articles of the curious serpent and green porcelain, the art of making which is unknown in Europe, and which is very rare even in China. They show you a set of china in exchange for which August der Stark gave Frederic I. of Prussia a fully equipped regiment of cavalry! But the most beautiful thing by far in the collection is a piece representing the crucifixion. It is of white porcelain, very large, and cost $20,000, about £3000. The figures in this, their expression and grouping, are exquisite."

1326. *The Berlin manufactory of porcelain* was founded by Frederic the Great, who, when he conquered Saxony, carried away several of the best workmen from Dresden. Five hundred workmen are generally employed there, but, though the true materials are brought from Saxony, the Prussian porcelain has not equalled that of Dresden.

1327. *The most magnificent and perfect manufactory of porcelain in Europe is undoubtedly that at Sèvres*, eight miles from Paris, carried on at the expense of the French government. Here, under the direction of M. Brongniart, the celebrated chemist and mineralogist, not only every possible attention has been, for many years, paid to the selection of the best materials, and to all the various processes, but likewise good artists of all kinds are employed in painting the decorations with great taste. Every description of porcelain has been produced at Sèvres in the greatest perfection, and most magnificent specimens of large vases and other objects are prepared, chiefly as presents to various

potentates. The private manufactories of porcelain in France have benefited greatly by this munificence of the government, and, as no secrecy is observed, improvements find their way over the kingdom. To these causes must be attributed much of the superiority and cheapness of French porcelain. In Paris there are several manufactories of porcelain; one exists at Chantilly, and another at Passy, which supply our shops with vast quantities of their produce, notwithstanding the heavy duty of 30 per cent.

At Vienna there is a royal porcelain manufacture in high esteem, and some of the smaller states of Germany can boast of similar establishments.

1328. *What has been called Reaumur's porcelain* consists merely of glass vessels which have been heated to a red heat in sand, and then allowed to cool very slowly, when it is found that the glassy structure is destroyed, and the vessels are converted into a white opaque substance resembling stone-ware or porcelain. These vessels are then much more difficult to melt than glass, and have the advantage of resisting changes of temperature to a considerable degree. It does not appear, however, that they have been brought into use, or that there is any manufacture of them. They are, of course, not porcelain.

Principal porcelain manufactories in England. At Derby and in Colebrook such establishments have long existed. Subsequently, Worcester has become celebrated for its porcelain, and the superior kinds of earthen-ware, where, at Chamberlain's royal porcelain works, the painting and gilding have been carried to a considerable degree of perfection. Yorkshire has also a china work at Swinton near Rotherham, and another exists at Rockingham, where some articles have been made of great beauty. It is difficult to pronounce upon the comparative merits of these, as the porcelain of each manufactory excels in some particular quality. One had been carried on formerly for some years at Nungarrow, in Wales, where the wares produced are considered to have been superior to any that have been manufactured in this kingdom, but the public patronage was not sufficient, and it was discontinued. The amateurs and collectors of porcelain now give greater prices for Nungarrow porcelain than when the manufactory existed. *Iron stone china* is a new variety of ware, which has some valuable properties: it is extremely strong, and resembles the older and coarser porcelains of China. Its composition is said to be 60 parts granite, 40 China clay, 2 flint glass; glaze, 30 parts granite, 15 flints, 6 red-lead, and 5 soda.

1329. *The present fashion in porcelain appears to be* to revive that style which, though prevalent about a century ago, became almost obsolete, yielding to a purer taste derived from the study of Grecian art. The Dresden porcelain was more remarkable for the excellence of the material, and the mechanical skill displayed in the modelling a variety of forms of difficult execution, and likewise for the colouring and gilding, than for the good taste displayed, in general, in the choice of subjects and the forms produced. Although occasionally there was considerable skill exhibited in them as works of art, and figures and flowers of various classes were executed in porcelain with a delicacy of finish truly admirable, and such as had never before been even attempted in such materials, yet the taste degenerated too often into the puerile, and the public appears to have been tired and satiated at length with shepherds and shepherdesses leading young lambs, and the innumerable conceits and grotesque absurdities executed for the mantelpiece, and which are yet treasured up in old china shops. Not confined within the limited range of subject and form in the imitation of the antique style of pottery, everything was attempted in porcelain that the modeller could execute. The brilliancy of the colours and the gilding employed in its decoration often drew the attention from the bad taste displayed in the subjects, and gaudiness and ostentatious finery took place of the modest but exquisite elegance of ancient art. This, in fact, corresponded with the general style of the period when these works were executed. The improvement of taste, by the study of antique remains, at length drove those from the field, and consigned them to the collector's closet. The revival of these species of porcelain in its original freshness, but without its worst peculiarities, appears at present to have fascinated the public, and has given the semblance of novelty to a style which is far from being new, and is producing a change which it is difficult or impossible to speculate upon. One circumstance may be regretted, that the fine things executed under Wedgwood are disappearing fast, without the substitution of what can bear a comparison with them; and what is now executing instead, not demanding those accomplished artists which he had the liberality and the spirit to patronise, the art of pottery cannot be expected to rise, at least in point of design. But it must be admitted, nevertheless, that nothing can exceed the richness of the painting and gilding on modern services of plates, dishes, and other vessels for the table. To be comprehended, they must be seen in their numerous repositories and show-rooms in the shops of the metropolis, to which we must refer the reader, who will be gratified by an examination of the numerous articles of this kind, both English and foreign. To treat of them in detail would far exceed the limits of our present work.

SUBSECT. 4.—*Purchasing and mending China.*

1330. In purchasing china, it is well to deal with shops that are supplied from known and respectable sources, for a great deal of badly manufactured goods, such as we have described, is sold in this kingdom at low prices, frequently hawked about by pedlers, in which the glaze is so slight as to crack after being cleaned a few times in hot water.

1331. *When holes are required to be drilled in china or earthen-ware,* for the purpose of riveting it when broken, the usual method is to use a drill made of a splinter of diamond set into a handle, and this is an effectual mode; but as a diamond may not always be at hand for this purpose, it is useful to know that holes may be worked in these materials without it. Procure a three-cornered file, and harden it completely by making the end red hot, and plunging it into cold water; then grind the point quite sharp on a grindstone, and afterward on an oilstone. Then, with the point of this tool, pick repeatedly on the spot to be bored, taking care not to use too much violence lest the object should break. In a short time, or in a few minutes, by a continuance of the operation, a small conical piece will be forced out not bigger than a pin's head, and the hole may afterward be widened by introducing the point and working the file around.

1332. *The best cement for broken china or glass is that sold under the name of the Diamond cement,* which is colourless, and resists moisture. This is made by soaking isinglass in water till it is soft, and then dissolving it in proof spirit. Add to this a little gum ammoniac, or galbanum and mastic, both dissolved in as little alcohol as possible. When the cement is to be used, it must be gently liquified by placing the vial containing it in boiling water. The vial must be well closed by a good cork, not by a glass stopper, as this may become fixed. It is applied to the broken edges with a camel's-hair pencil.

1333. *When the objects are not to be exposed to moisture,* white of an egg alone, or mixed with finely sifted quicklime, will answer pretty well. Shell-lac, dissolved in spirits of wine, is better.

1334. *A very strong cement for earthen-ware* is made by boiling slices of skimmed milk cheese with water into a paste, and then grinding it with quicklime in a marble mortar, or on a slab with a mallet.

CHAPTER XVI.

ON GLASS.

SECT. I.—HISTORY OF GLASS-MAKING.

1335. This substance has now become so familiar to every one in civilized society, that many are not aware that its general use is comparatively modern. To form a just estimate of its importance, we have only to carry our ideas back to those times when it was unknown, or consider what would be our condition if deprived of this valuable material. Although the invention of glass dates from a remote period, it is scarcely above a century or two that its use has become general in the windows of domestic edifices; and to this day a great part of the world has not yet learned to employ it for this purpose. It is curious and interesting to reflect how much pleasure and convenience have been added to our habitations by the introduction of glass windows. The compactness of this admirable substance renders it efficacious in excluding the fiercest shower or keenest wind, while its transparency allows the rays of light to pass through without obstruction. By these means, therefore, the house is rendered not only warm, but light and agreeable, and the sight may, at the same time, be gratified with the beauties of a fine country or a delicious garden, and all that passes without may be distinctly seen from the interior of the building.

1336. *The discovery of glass* is involved in the same obscurity as many other inventions important to mankind. Accident probably first produced it, and the vitrification of various substances by a high degree of heat being observed by some reflecting person, would naturally give rise to experiments that might ultimately lead to some process for obtaining it at pleasure. Numberless instances must have occurred of the occasional fusion of earthy substances by means of intense heat, as in the making of pottery and bricks, and masses of coarse glass are often found in places where great fires have been. We are, indeed, informed by Pliny that, according to tradition, glass was discovered in the following manner: a merchant ship, laden with fossil alkali, being driven upon the coast of Phœnicia, the sailors, in cooking some provisions on the shore, had made use of pieces of the alkali to support their kettle, in consequence of which a vitrification of the sand took place, the alkali acting as a flux, and that this gave the first hint for the manufacture of this material. Whether this was the actual manner in which the discovery was made or not, nothing is more probable than the story, and we find that the earliest accounts attribute the manufacture of glass to the inhabitants of Tyre and Sidon; but the first that was made was no doubt extremely imperfect, and destitute of that beautiful and complete transparency which distinguishes it at present.

1337. *Glass-making appears to have been known in Egypt at least before the year* 1800 *before our era.* Judging from ancient Egyptian paintings at Beni Hassan, which appear to indicate the process, an ancient glass bead bearing the name of one of the Egyptian Pharaohs, who lived at the period alluded to, leaves no doubt as to its early use in the valley of the Nile. The Egyptians were not only acquainted with glass, but knew how to stain it of various colours; for many articles of coloured glass, made with extraordinary skill, are discovered among the antiquities of that country.

1338. *But the art of depriving glass entirely of colour, and rendering it as transparent as crystal,* were subsequent improvements. It appears that a very extraordinary value was put upon some vessels of transparent glass which the Emperor Adrian received at Alexandria; and from some small panes of glass, thick and not very transparent, which have been found in the windows of antique baths in Pompeii, it appears that these were not unknown to the Romans latterly; among them, however, this employment of glass never became general. When windows in private dwellings were required, various contrivances were resorted to, as lattices, parchment, and transparent membranes, or linen stretched across frames, and even thin plates of semi-transparent stones, as mica, selenite, or alabaster. In warm climates the necessity for excluding the air and cold by these means was not so obvious as in colder countries; and, for common houses, glass is at this day very little used in many parts of Spain, Portugal, and the East. Although the employment of glass, for admitting light into private houses, appears to have been but little practised among the ancients, yet drinking vessels and bottles of glass were latterly sufficiently common among the wealthier classes, this circumstance being mentioned by Horace, Pliny, and other classic authors, and numerous specimens of these have been found in the ruins of Pompeii. Glass was introduced into India by the Europeans; and it is said that the Chinese to this day are only able to make glass vessels out of broken glass made in Europe.

1339. *The Venetians were the first Europeans who excelled in the manufacture of glass;* and panes for windows used to be imported into Britain for churches in the fourth and fifth centuries; but their employment appears to have been at that time limited to ecclesiastical buildings, and the comfort of glazed windows in domestic edifices was little known, even down to a very late period. In the year 1567, the glass casements of Alnwick Castle were only put in when the lordly proprietor visited the place, and were taken out and put aside for safety when he was absent, which may give us an idea of their rarity at that period. It is supposed that glass windows were first introduced into gentlemen's houses about the reign of Henry VIII., and that they were not used in farm-houses prior to James I. In Scotland, so late as 1661, the windows of ordinary houses were not glazed, and only the king's palaces could boast of this advantage. Previous to the use of glass in England, windows were filled with wicker-work, or with lattices of oak laths placed checker-wise. In some cases the rich used casements filled with panes of horn.

SECT. II.—COMPOSITION OF GLASS.

1340. Notwithstanding the extraordinary beauty and singular properties of glass, it is made from materials which are very abundant and easily procured. Glass of some kind may be made by exposing a mixture of various earthy and saline materials to a high degree of heat, by which they are fused or vitrified.

1341. *But for that kind of glass so valuable in domestic economy, two substances are essential, namely, siliceous earth in a state of considerable purity, and an alkali.* Siliceous earth, in its various states of quartz, sand, flint, &c., is infusible by itself in the most powerful furnace; but when mixed with a certain quantity of any alkali the mass fuses very readily, and glass is the result. Nothing, therefore, is easier than to make mere glass; but the transparency and perfection of this substance depend upon a proper selection and management of the materials: without this, the glass will turn out to be almost opaque, and very imperfect. Both soda and potash are employed as the alkalies: they are used in the state of carbonates, and the carbonic acid flies off during the process, leaving the alkali by itself to combine with the silica.

For the very best glass pure alkali is necessary; but for the inferior sorts the coarser kinds of alkali, as barilla, kelp, or wood ashes, are made use of. Lime, an alkaline earth, is also used occasionally as a flux. In almost all the materials commonly employed there are more or less of impurities which would injure the glass; besides, therefore, the silica and alkali, certain additions to these ingredients are made in the best kinds, in order to destroy the colour and opacity that would otherwise result, or to give the glass particular properties. Nitre and oxyde of manganese are added, to get rid of colouring matters; hence the latter has been called glass-makers' soap; but if too much manganese is used, the glass will have a purple tinge: a small quantity of arsenic is used for the same purpose. The latter is not free from danger to health if the glass should contain so much alkali that any part of it is soluble in acids. The oxydes of lead, chiefly litharge and red-lead, are found to be of singular use in the manufacture of the finer kinds of glass, rendering it more dense, though softer and easier to

cut. The French use more lead in their glass than is the practice in this country; on this account their glass, though more brilliant, is softer. In glass, but particularly in flint glass, more alkali is used than is necessary to flux the sand; and when the whole is in fusion, the fire is continued so as to volatilize the superabundant quantity. But if too large an excess of alkali be left in the glass, it will attract water from the atmosphere, and be partly dissolved; and to this cause may be attributed the decay of some old glass. Indeed, a certain proportion of alkali fused with the silica will make a glass that will even completely dissolve in water.

Sect. III.—Process of Glass-blowing.

1342 *The general process employed in the manufacture of glass is the following:* premising that all those who have never yet witnessed it should take the first opportunity of visiting a glasshouse, since no verbal description alone can convey a perfect idea of the extraordinary, and apparently almost magical, dexterity by which all the various articles of glass in daily use are made. Glasshouses are commonly large, conical buildings, from 60 to 100 feet high, and from 50 to 80 feet in diameter, having the furnace in the centre.

1343. *When the materials are properly prepared by a process called fritting*, which is a commencement of vitrification, they are thrown into a large kind of crucibles or pots, which have been previously brought to a white heat in the furnace in which the fusion is made. Great care is bestowed in the fabrication of these crucibles or glass pots, as they must resist the most intense heat without melting or cracking. They should consist of five parts of the best Stourbridge fire clay, and one part of old broken crucibles ground to powder, and a red clay. Great nicety is required in kneading and mixing these together, for the breaking of a pot would be a serious accident. They are about forty inches deep and wide, and from two to four inches in thickness. In about thirty or forty hours the materials melt, and gradually a white porous scum rises to the surface, called *glass gall:* this consists of salts and various impurities in the glass, which is not perfect until the whole of this is removed: it is purchased and used by the refiners as a powerful flux. To ascertain the purity of the glass a little is taken out from time to time. A very intense heat is necessary, because the alkali will not combine with the silica until the carbonic acid and water are completely driven off, and it retains the last portion of these with remarkable obstinacy: when that is effected the combination and fusion take place. The fuel employed in this country is coal: in France they use wood. In the glasshouses the workmen are employed day and night, because it is necessary that the work should go on without intermission till all the melted glass in the furnace is exhausted.

1344. *Every object of glass, plate glass excepted, is formed from a hollow globe that has been produced by blowing.* The principal implement used by the glass-blower is an iron tube about five feet long. This he dips into the pot with melted glass, which has been suffered to cool till it has acquired the proper consistence, as at first it is too fluid, and a proper quantity of material is taken out adhering to it. The workman now applies his mouth to the tube, and blows strongly through it, causing the glass to be distended by degrees into a hollow globe. By alternately heating this again at the mouth of the furnace, blowing it larger, and occasionally rolling it upon a flat table, and fashioning and cutting it with various tools, the plastic substance is at last skilfully made into all the various articles in use. As soon as the various pieces are finished, they are put into the *annealing furnace*, where they are heated to a particular temperature, and then suffered to cool very gradually.

1345. *Glass, brittle as it is, would be much more so were it not annealed;* the annealing consists in again heating the various articles of glass and letting them cool very slowly, and when this operation is imperfectly performed, it is more brittle than ordinary; window glass in that state cuts badly with the diamond, and often flies in a direction different from that which was intended.

Sect. IV.—Properties of Glass.

1346. *Glass, when well made*, is perfectly transparent and colourless. It is very brittle when cold, but, by the application of a high degree of heat, it becomes so flexible and tenacious as to be readily fashioned into any form that fancy may dictate, or may be made so fluid as to be pressed into moulds. Its ductility is so great, when soft, that it can be drawn out or spun into elastic threads of extreme fineness, and these retain their elasticity for any length of time. Glass is absolutely impermeable to air and water, even under any degree of pressure; and we mention this fact the more particularly, because many persons suppose that some fluids can pass through glass under certain circumstances; but this is an error. What has led to this erroneous idea has probably been observing that drops of liquid sometimes appear upon the outsides of vessels, and the supposition that they must have passed through the glass; but in such cases these drops are generally precipitations of water from the atmosphere upon the cold glass in the manner of dew, or some of the liquid having got through the cork.

Another valuable property of good glass is, that it cannot be corroded by any liquid except one, the fluoric acid: hence vessels formed of it are capable of containing all kinds of fluids, even acids, without any injury, which is not the case with metal and other substances; and its transparency enables us to judge of the state of the fluid within. As it is not acted upon by any ordinary liquids, it imparts no taste of any kind to what is kept in it; and, from its smooth, unalterable surface, it is easily cleaned, and its transparency enables us to see whether the vessels are perfectly so. No other substance has these valuable properties, from which, however, it must be admitted that its great brittleness is a considerable drawback. It may be observed that glass, when well made, although so easily broken by mechanical violence, is absolutely unchangeable by decomposition in the greatest length of time. It is therefore now used for enclosed medals and other objects that are placed in the foundations of buildings, for the information of remote posterity. Many attempts have been made to destroy the brittleness of glass, and to render it malleable, but without the least success. Glass, though brittle, is considerably hard, but not so much so but that it can be ground by other substances harder than itself, as sand, emery, &c., and it is polished by using finer and finer powders. This property renders it capable of admitting of much ornamental work, by cutting in vessels of various kinds, which very much increases its beauty; and it may thus also be formed into lenses for spectacles, telescopes, and microscopes, instruments which have enlarged the bounds of human knowledge to a most extraordinary degree.

1347. *Glass is one of the most elastic bodies in nature.* This elasticity may be well seen in a bunch of spun glass used as ornament; and, on account of its great elasticity, it has been even employed as a watch-spring. This elasticity may also be perceived in the well-known musical glasses, which consist of goblets filled partly with water; when the wetted finger is drawn over the edges of these glasses a musical note is produced, and the vibrations of the glass may be distinctly seen by means of the water.

1348. *Silica and alkali are not the only substances from which glass may be made.* Borax has long been known to be the most powerful flux for silica, and its high price in this country is the only objection to its general use; but a certain quantity of it is always employed in the finer kinds of plate glass, and those other kinds of the manufacture that are required to be absolutely free from specks and bubbles. Glass made with it flows remarkably thin, and fit to be cast into a mould. In consequence of various experiments made lately to improve the glass for optical instruments, boracic acid has been substituted for alkali, and glass has been made of that and silica, which is more free from imperfections than flint glass. The composition of some made by Mr. Faraday is, boracic acid, 24; silica, 16; protoxyde of lead, 112.

Sect. V.—Various kinds of glass in common use.

1349. There are several different kinds of glass in common use, manufactured for various purposes. 1. *Flint glass*; 2. Window glass; 3. Plate glass; 4. Bottle or common green glass. We shall consider each of them separately.

1350. *Flint glass* derives its name from having been made originally from flints calcined and ground, and then fused with alkali. Flint, it must be observed, consists wholly of siliceous earth. But it is now found that fine white sand, which consists of small grains of quartz, also siliceous, answers the purpose better, and the flints are laid aside, although the name is retained. The very white sand found at Alum Bay, in the Isle of Wight, and at Lynn, in Norfolk, are made use of instead. Flint glass is the most beautiful kind, and is that which is always used where cutting is required. It is distinguished from the other kinds of glass by having in it a certain proportion of oxyde of lead, to which it owes some of its most valuable properties, particularly its greater density, by which it refracts the light more strongly, and, consequently, exhibits more beautifully the blue, red, and yellow rays in cut ornaments. It is softer than other glass, which renders it easier to cut and to polish.

1351. *Every manufacturer has some particular ideas respecting what he thinks the best proportion for his materials*; but the usual mixture for flint glass is, fine white sand, 120 parts; well purified pearlash, 40; litharge, or red-lead, 35 parts; nitre, and a small quantity of the black oxyde of manganese, 13. Some flint glass analyzed by Mr. Faraday gave, in 100 parts, silica, 51·93; oxyde of lead, 33·28; potash, 13·77, with minute portions of other substances.

1352. Great care is taken to select the sand for the purpose. It is then well washed and calcined, and mixed with very good alkali. The process of blowing and fashioning the various articles is such as we have already noticed in a general manner. If it be required to give an article some form not attainable by the ordinary methods, a mould is provided, into which the glass is placed when blown, and where it receives an impression with as much facility as wax.

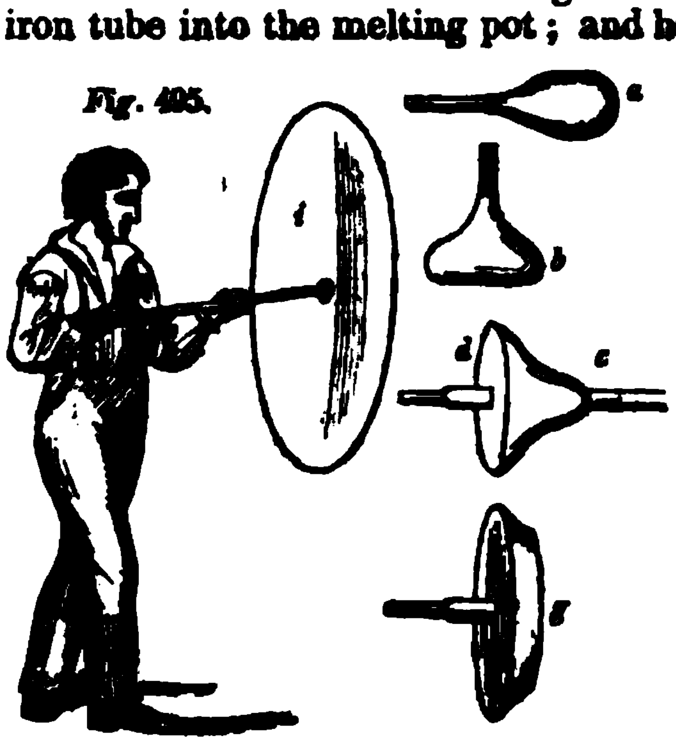
1353. Of flint glass are made all our decanters, goblets, and the usual drinking-glasses; in short, all the glass brought to table. This is the only glass employed for optical purposes, for making glasses for telescopes, spectacles, and other instruments;

consequently, great endeavours have been made to improve its quality. Of this glass, also, are made thermometer and other tubes used by the chemist, which are sometimes extremely fusible, so as to be easily bent, by means of heat, into any form, and to be worked by the blowpipe into various ornaments.

1354. *Window glass* differs from flint glass in containing no metallic oxyde except a little manganese to destroy the green colour derived from combustible matter or iron in the materials. It is harder than flint glass, and would not be so easily formed into various shapes. There are two kinds of window glass in common use, of which the best is termed *crown* glass; the inferior sort is called *broad* glass. These differ in their composition and mode of manufacture. The composition of crown glass some years ago was, fine Lynn sand, 6 bushels; kelp, 12 bushels. In the excellent crown glass formerly made at Radcliffe Highway, London, Spanish barilla was used as the alkali instead of kelp; but soda is now generally employed in the manufactories.

1355. *To make crown glass*, the materials are first subjected to an operation called *fritting*. For this purpose, they are thoroughly mixed and calcined for about two hours in a degree of heat not equal to that of complete fusion, but sufficient to render them pasty, and they are well stirred for three hours more, that they may be thoroughly incorporated. This occasions the dissipation of what volatile and gaseous matters there may happen to be present. When in this pasty state, the mass is of a grayish-white colour; and while soft it is cut into brick-shaped pieces, which, after cooling, are piled up for use. By long keeping, an efflorescence of soda appears on the surface, and the glass-makers consider it as improved by lying by some time. These pieces of frit are put into the melting pots, old glass being piled up with them, and the heat of the furnace is increased so as to bring the whole into fusion. The glass-blower now dips his iron tube into the melting pot; and having gathered as much glass round the end of his iron tube as is sufficient to form a table of glass, he blows it into a ball in the usual way, and works this into the form of a pear, *a*, *fig.* 495. Having done so, he next, by pressing its end against a flat surface, gives it the form *b*, which is called *bottoming*. He now heats it again at the mouth of the furnace hole, and, by whirling it round, brings it to the shape *c*, the bottom being more extended than it was. Another workman now takes out some melted glass, *d*, upon the end of another smaller rod, and attaches it, while hot and soft, to the middle of the flat bottom thus produced. The first workman next touches his glass at the spot where it is attached to his blowing-rod, *c*, with a cold iron which has been dipped in water, which causes the glass to crack at that place, and then the rod is easily detached from the glass, which has now an opening where the fracture took place. Taking now hold of the smaller rod, *d*, the glass-blower presents the glass with the small hole at *c* to the heat of the furnace, and keeps whirling it round more and more rapidly. This causes the diameter of the bottom to increase by the centrifugal force, as well as the opening which has been made; and when the whole has assumed the form at *g*, the glass flies open in a surprising manner with some noise, called *flashing*, and presents the appearance of a simple disk, *i*. This last part of the process strikes the stranger with astonishment, and he is ready to expect the whole to fly into pieces. However, by turning more slowly in the air, the glass cools gradually in the form of a disk, or circular flat table, until it is solid. The place in the centre of the circle where the rod is attached is the knot often seen in glass panes called a *bull's eye*. The glass is now sent to the annealing furnace, where it is annealed with great care, lest it should warp. From these disks, called *tables*, the ordinary panes of crown glass are cut by a diamond; and it is obvious that the larger the disk the larger pieces they will afford. Notwithstanding the care employed in this process, all the tables of glass are not of the same quality, and some will be flatter and freer from blemishes than others, and will therefore enable the glass-cutter to cut larger panes of good glass out of them, on which account crown glass is sorted into firsts, seconds, and thirds, which vary in the price according to the quality. This kind of glass is peculiar to England.

Fig. 495.



1356. *Broad or spread glass* is an inferior window glass, called also green window glass, and is made from somewhat less pure materials: fine sand, 5 bushels; kelp, 11 bushels; slacked lime, 5 bushels. But the inferiority of these alkalies does not prevent them from dissolving the silica into a good glass, though less beautiful than the last kind. The carbonaceous matter, which would injure its colour, is chiefly burned out, and separated in the first process, called *fritting*, after which the materials are thrown into the melting pots. This glass, when of the commonest sort, has always more or less of a greenish tint from the iron which exists naturally in the ingredients, and it is

liable to be altered by long exposure to the weather, particularly in places where noxious effluvia occur, such as sulphuretted hydrogen. This may be frequently perceived in old cottages, and other buildings where it has been used. At present this kind is little employed, the price being nearly the same as inferior crown, which is much preferable to it. It is, however, found particularly useful to glass stainers. The manner of making it is different from that of crown glass. The glass-blower having formed a hollow sphere by blowing, stops up the end of his tube through which he blew, and holds the hollow globe at the mouth of the furnace, when the air within the glass, expanding by the heat, bursts it in a rent, which is completed by shears. The glass is then flattened upon a table, and detached from the tube. The flattening cannot be performed very perfectly, which is the cause of many defects in the tables, which have usually a wrinkled surface.

1357. *Plate glass* is made in two modes. One kind is made by blowing; the other is by casting, or causing the glass to flow on a smooth table in the same manner as sheet lead. The materials for this kind of glass are very well selected, consisting of fine white sand, soda, and lime, the latter substance having, likewise, the quality of a flux. Soda is preferred to potash, because it makes the glass flow thinner. Parkes recommends the following proportions: Lynn, or Alum Bay sand, 720 parts; alkaline salt, containing 10 per cent. of soda, 450; quicklime, 80; nitre, 25; broken pieces of plate glass, 425.

1358. *Plate glass made by blowing* is sometimes called *British sheet glass*. A globe is first formed, as in the ordinary processes; then this is, by rolling on a table and farther heating and blowing, converted into a cylinder, which is at length cut open by a pair of shears and laid out flat. The great weight of the glass prevents these from being made of a large size. Plates that are blown cannot be properly made above forty-five, or, at most, fifty inches in length, and with a proportionate breadth; if made larger, they are two thin, and are, besides, liable to warp, which injures their value for mirrors, as they distort the objects viewed in them.

1359. *Mirrors of glass* were first manufactured by the Venetians, who long kept the art a secret. These glasses were blown, and they supplied all Europe, but by this process perfect glasses could not be produced more than fifty inches long.

1360. *The best plate glass* is made by casting. The art of casting glass was invented in France by Thevart, in 1688, and the manufactory established at St. Gobin still exists.

A sufficient quantity for the plate required is melted in a vessel called a curvette; and a very solid table is provided, sometimes of iron, to cast the fluid glass upon. The curvette is brought by means of a crane to the table, which is surrounded by a low ledge, and the glass, after being poured out upon it, is smoothed and made of equal thickness while hot, by a hot roller that passes across from one ledge to another. The plate, when cool, is annealed, and squared by cutting with a diamond. The surface is then ground quite flat by flint powder and emery, and polished by crocus martis, well washed. There is great difficulty in procuring large plates quite free from flaws, and when any are perceived after the plate is cast, it is diminished by taking off a part, and this, perhaps, may do for a smaller mirror; but several castings may be required before they can procure one of the full size required.

At present the principal manufactory of plate glass in this country is at Ravenhead, near Prescot, in Lancashire. The company to which this belongs is incorporated by charter, and mirrors are made equal to any in the world. Their office is in Albion-street, Blackfriars Bridge, London. The following table exhibits the sizes and prices of plate glass made by them:

Dimensions.	Surface in square Inches.	Price. £ s. d.	Dimensions.	Surface in square Inches.	Price. £ s. d.
60 inches by 30 inches	1·800	10 10 1	100 inches by 60 inches	6·000	63 15 1
60 ——— 40 ———	2·400	16 3 5	100 ——— 70 ———	7·000	80 6 2
60 ——— 50 ———	3·000	22 10 5	100 ——— 80 ———	8·000	98 4 10
70 ——— 50 ———	3·500	26 7 8	132 ——— 84 ———	11·088	200 8 0
80 ——— 50 ———	4·000	34 14 10	160 ——— 80 ———	12·800	246 15 4
100 ——— 50 ———	5·000	46 9 8			

From this table it will be seen that the price is not simply by the superficial foot or inch, as in many other materials, but that it increases by the square inch according to the size of the plate.

It has been observed that some plate glass acquires a purple tinge by exposure to the sun's rays, and that this takes place so rapidly as to be distinctly seen at the end of one or two years in plates that were colourless when new. We may point out as a proof of the great increase of wealth and luxury, the use of plate glass, not only in mirrors, but likewise in windows of houses of the higher class, and even in those of shops, which it is not uncommon to see in London, consisting only of two or three panes of plate glass, and sometimes a single pane of great size.

1361. *German plate* was a large variety of well-made glass formerly imported, chiefly

for the purpose of covering drawings and prints; but England is now independent of any foreign manufacture of glass. The German plate was made by blowing, as above described.

1362. *Common bottle glass* is of a dark or dirty green colour, and forms the largest quantity of glass made in Britain. Its composition varies in different parts of the kingdom, being made of coarse sand, lime, and clay, with any alkaline refuse that can be procured, such as soap-makers' waste ashes. Large quantities of this, as well as the other kinds of glass, are made at Newcastle on account of the cheapness of coal, of which only the small refuse, called slack, is used, being found sufficient, and which there costs little more than the carriage. Lime and sea-sand are the materials usually employed for this glass at Newcastle, the mass being frequently wetted with salt water, the soda of which is useful in assisting the fusion. Bottle glass is a hard, well-vitrified glass, and will resist the corrosion of acid liquors better than flint glass, and is not so easily softened by heat, having no lead in its composition. The green colour is owing to iron, which is naturally mixed with the materials. In some countries it is made by fusing basalt. On account of the coarseness of the materials of which bottle glass is made, there is frequently much carbonaceous matter, and this, during the fusion, is burned and converted into carbonic acid gas, which gets enveloped in the pasty soft glass, occasioning bubbles and blisters, which frequently injure and disfigure it. It is necessary, therefore, to keep up the heat after the materials are melted until the carbon is consumed. Government will not allow the makers of this species of glass to use any but the common sand, lest the glass should be too good, and the revenue be defrauded by its being applied to purposes for which the best glass is generally used, and which pays a higher duty. Of this glass are made bottles, garden bell glasses, large chemical retorts, carboys, &c. Thin glass is less liable to break than thick by sudden changes of temperature, and the common green glass than the white; hence the flasks of green glass in which olive oil is brought, generally called *Florence* flasks, are made very thin, and are particularly useful for boiling liquids where glass is required.

1363. *The most usual defect of window glass* is the waviness arising from an imperfect mixture of the materials, as also the striæ or threads, knots, and bubbles, which disturb the rays of light in passing through, and produce confused and indistinct vision. It is from the surface of polished plate glass being rendered absolutely flat, that objects are seen through it without any of that distortion which always takes place, more or less, in common glass. These defects are so difficult to avoid entirely, that it has not been possible hitherto to obtain a single pot of glass absolutely free from them; although this is a desideratum in those glasses which are ground into lenses for telescopes. Since the entire absence of colour is one of the qualities of perfect glass, any kind of tinge is an imperfection. Glass has sometimes a violet hue from too much manganese, or it is green from iron; and an over proportion of lime is apt to communicate to it a smoky tint. These colours cannot always be discovered, except by looking at the edge of the glass. When window glass is much warped, there is not only the inconvenience of the objects which are seen through it being distorted, but it frequently happens that it is difficult to secure it properly in the sashes without using small tacks for the purpose; and if the glazier is negligent, the wet gets in.

Previous to taking off a considerable part of the duty on glass lately, a large quantity of the smaller glass articles was made in an illicit manner, and these were generally of bad quality, and imperfectly annealed: it went under the title of "Jews' glass." But it is said that less of this is made at present, the price of good glass being considerably reduced.

Sect. VI.—Cutting and Grinding Glass.

1364. *The art of cutting glass is much more modern* than that of painting and staining it. At present the richness and brilliancy of our vessels of glass, which contribute so much to the ornament of our tables and saloons, are owing, in a great degree, to the elaborate and elegant manner in which they are cut. The cutting is effected by wheels driven by considerable power, the glass being held to the wheels. The first cutting is with wheels of stone, then with iron wheels covered with sharp sand or emery; it is then polished in the same manner by putty, or oxyde of tin. To prevent too much heat being excited by the friction, a small stream of water is kept constantly running on the glass. In large manufactories the wheels are urged by a steam-engine.

1365. *Glass may be ground* by hand on any coarse-grained sandstone, or with sand, or with emery and water.

1366. *Panes or flat pieces of glass may be divided*, when a glazier's diamond is not at hand, by making a notch with a file and carrying a piece of hot charcoal in the line in which it is wished the fracture should proceed. The charcoal must be kept alive with the breath. A red-hot iron will also do.

1367. *The art of casting in glass has lately arrived at such perfection* that many articles, such as small plates, salt-cellars, &c., now almost rival, at first sight, those that are cut; and glass casting has one advantage over glass cutting, that certain orna-

ments can be cast that could not be cut with the wheel; but no casting has yet quite equalled the sharpness and beauty of cut glass, and, indeed, cannot bear close comparison with it.

Sect. VII.—Coloured glass and enamel.

1368. *Coloured glass is perhaps nearly as ancient as the material itself.* Egyptian mummies are found decorated with coloured glass beads, which must be 3000 years old. Several examples of coloured glass have been found among the ruins of antique buildings, which prove the skill of the ancients in this art. The oldest specimens of coloured glass in churches resemble a kind of mosaic, and were composed of panes of glass that had been coloured throughout in making, joined together by lead.

1369. *But the modern method of painting on glass*, or, as it is called, *staining glass*, consists in the application of colours to the surface of uncoloured glass, and then exposing them to heat in a furnace, by which the colours strike into the glass and are permanently fixed. The colours are the same as those used for enamel, and are united with some substances which serve as flux. Only three colours, orange, red, and yellow, can be floated on as stains; all the others are hatched on by the strokes of a brush. Oil of spike is generally used to work with the colours.

So far from the art of painting of glass being lost, as some have stated, it is now practised in greater perfection than ever, with the exception of a fine scarlet seen in old churches, which, it is said, cannot now be produced of equal richness. Pictures in stained glass are executed with a vigorous and natural effect of light and shadow entirely unknown to our ancestors. Lately a great deal of coloured glass of the richest hues, in a great variety of utensils for the table and the boudoir, has appeared in the London shops. These are chiefly of Bohemian manufacture, although we are beginning to imitate them. Some of these vessels are of elegant forms, and often gilt with delicate ornaments. In some of them, coloured glass ornaments are laid on vessels of colourless glass.

1370. *Opaline glass* is of a semi-transparent opaline hue, used for various ornamental articles, chiefly for the boudoir. The effect is produced by adding to the best glass a small quantity of oxyde of tin, or, what is better, phosphate of lime, or well-burned bone ash.

1371. *Glass ornaments of two colours* are now made in the following manner: Sufficient glass of one colour is collected on the working-table for blowing, and is then dipped into a pot of another coloured glass. This mass is then blown and moulded into a vessel of the required shape, and the exterior coating being cut away in parts by the glass-cutter, the inner glass is exposed to view. In this, therefore, the projecting parts will be of one colour, and the cut parts of another, the effect of which is often extremely elegant.

1372. *An ornamental glass, resembling medallions, crests, or other ornaments let into transparent glass*, is made thus: The ornament to be let in is moulded in a peculiar kind of clay, and is introduced by the glass-maker into the glass while soft, having then the appearance of unburnished silver. Glass door-handles, decanters, girandoles, and other articles made of flint glass, are thus ornamented with arms, crests, medallions, &c.

1373. *Enamel is a glass rendered opaque by having an admixture of oxydes of metals with a flux.* For the white enamel of the dial plates of clocks and watches oxydes of tin and lead are employed; and coloured enamels are used for making a number of ornamental articles.

In painting in enamel, the colours are formed of this basis and mixtures of the oxydes of various metals, as iron, copper, manganese, &c. When these are finely levigated and laid upon an enamel ground, heat is applied sufficient to flux them, and thus they sink into the ground, and become permanently fixed. This kind of painting is highly esteemed on account of its perfect durability. The art of enamelling is of great antiquity, and probably coeval with that of making glass. That it was practised by the Egyptians is evident from specimens found with their mummies. From them it passed to the Greeks and Romans, the latter of whom introduced it into this country. Various Roman, British, and Saxon enamelled trinkets have been found in England; and a gold cup, ornamented with enamel, given by King John to the corporation of Lynn in Norfolk, is still preserved. Enamelling is generally done upon grounds of metal, which must be so difficult of fusion as to resist the heat necessary to melt the enamel: gold is best, but copper is most usually employed.

The imitative enamel used for the dials of Dutch clocks is a kind of japan painting, and is not formed of glass.

Sect. VIII.—Glass beads.

1374. *The manufacture of glass beads is simple.* A short, thick rod of coloured glass, with a hole made through it: this is drawn out in a heated state by two men running in opposite directions, and by this very long tubes are procured of the size of the beads

required. These rods are chipped into short pieces of the length of the bead. The perforations in the pieces are then filled with sand and ashes by shaking them up with them in a bowl with a little water. This is done to prevent the bore from filling up when they are subjected to heat to cause such a degree of fusion as to take off the angles and cause the beads to acquire a globular form. They are afterward washed to separate the ashes, and are then strung by children. The largest manufactory in the world for beads is at a place called Murano, very near to Venice. Immense quantities of these, of above sixty different kinds, are exported.

For *imitation pearls*, see "Jewelry."

SECT. IX.—DUTY ON GLASS.

1375. The manufacture of glass is subjected to the excise; but lately the duty on flint glass has been reduced from sixpence to twopence per pound.

1376. *Some enthusiastic persons have imagined that we might easily procure glass in any quantity*, since it may be formed of the sand of the seashore and the ashes of burned seaweeds. But an acquaintance with the real processes of a manufacture will tend to correct these speculations. It is not every kind of sand that will do for making good transparent glass. It must be purely siliceous, and sand sufficiently so is very rare, and, of course, forms a valuable property to the owner of the land where it is procured. The glass-maker must, therefore, pay a considerable price for this material and its carriage; or should he use inferior sand, the correcting of the effects of the impurities, which give a bad colour to his glass, will be still more expensive. Flints will do, but they are not to be procured but in certain parts of the country, and they must be calcined and ground. The siliceous materials fit for a glass only half transparent, and of a dark green colour, are indeed extremely cheap, consisting of impure sand, or even basalt. Our native alkali used for glass is chiefly procured from kelp or from sea-salt, but requires considerable labour to produce. The vegetable alkali is imported, and though the woods of America and Norway are boundless, yet the glass-maker must pay a high price for his pearlash.

The ashes which we could make from common weeds, though useful in washing, would go a very little way in the manufacture of glass. The heat required for glass-making is intense; but to produce this, very large and strong furnaces are required to be built in an expensive manner, at a cost of several thousand pounds; added to which, workmen are necessary who have acquired great skill by long practice, and to whom high wages must be given. Capital also must be found, and talents to conduct a manufacture successfully. When all these circumstances are taken into the account, and none can be omitted in fair reasoning, it is easy to perceive that there are various natural limits to the cheapness of glass; and that although, by the improvements in manufactures, reduction of duties, and other causes, it is not difficult to contemplate the possibility of this very valuable material becoming still more abundant, and applicable to more purposes than it is yet applied to, yet an accurate knowledge of the general facts in its manufacture will correct extravagant expectations. Semi-transparent glass, which would admit a certain quantity of light, without allowing objects to be seen through it, might be made at a greatly cheaper rate; but, from what we have stated, it is obvious that making glass transparent and clear must always be an expensive process.

SECT. X.—GLASS MIRRORS.

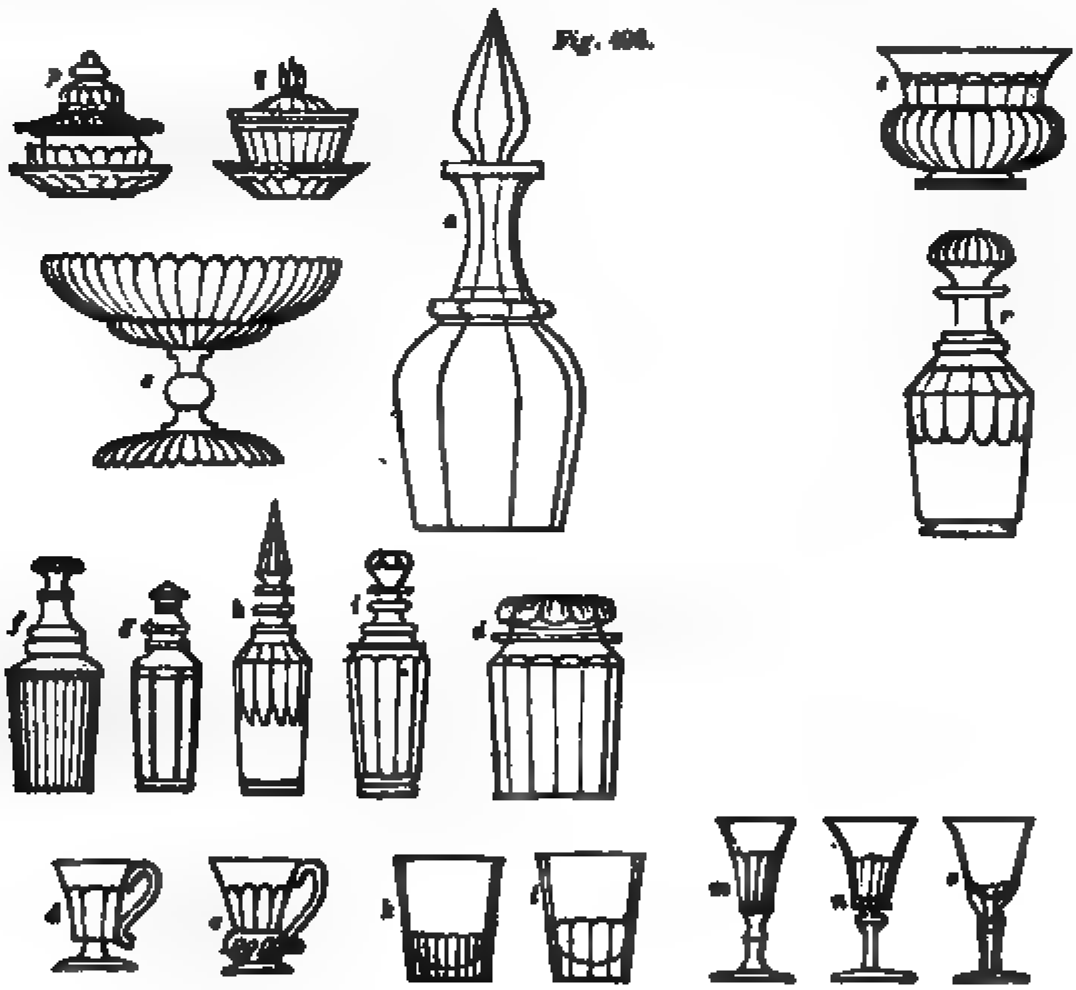
1377. *The silvering of glass for mirrors* is covering the back of the glass with a composition or amalgam of tin and quicksilver. There is only one position in which transparent glass, not silvered, even when ground perfectly flat and polished, reflects the rays of light so as to become a mirror; but the silvering causes it to reflect the light in all positions. The manner of applying the amalgam is peculiar. The tin is reduced by hammering into leaves as thin as paper; but, as any joinings in these leaves would produce unpleasant lines upon the mirrors, it is necessary to have a single leaf of tin as large as the mirror to be silvered. The leaf is then laid on a very smooth stone table covered with paper, and surrounded by a border of wood; mercury is then poured over it to the thickness of a line, and spread even with a roll made of cloth. The glass, properly ground and polished, is now to be slid in horizontally over the mercury, by one side of the wooden border being removed, but so carefully that it shall not touch the tin, and prevent any bubbles of air getting between. Care must be taken, likewise, that the glass should push before it any oxyde of tin or dust that may be on the surface; for, if this should adhere to the glass, it would form a blemish in the silvering that could not be remedied. When the plate of glass is completely over the amalgam, it is allowed to sink upon it by its weight, and the mercury that is thus forced out flows into a channel in the wooden border. The glass, being now covered with flannel, is loaded with weights placed all over the surface, and is at the same time tilted a very little to permit the quicksilver to drain off. After it has remained in this situation for a day, it is gently raised and cautiously removed, to be set up in a wooden frame for the soft, pasty

amalgam to harden. It is some considerable time before this has acquired its utmost degree of firmness; and globules of fluid mercury have been seen to drip from new mirrors even after they have been set up in a room; small portions of the amalgam are, at the same time, apt to be detached by any sudden concussion or jarring: defects which cannot be mended by any patching without leaving lines of junction visible. Glass mirrors have been made by the British Plate Company as large as 160 inches by 60 inches; value, £246.

Sect. XI.—Glass used as table furniture.

1378. The use of glass in furniture is too well known to require much illustration. We shall confine ourselves, therefore, to an enumeration of the various articles in common use. Mirrors have been already mentioned for chandeliers and other holders for lights in Section on Lamps. Glass for the table consists of decanters for the usual wines, *a*, *fig.* 496; ditto, for claret, *b*; liquor bottles, *r*; water jugs, *c*, *c*; pickle glasses, *d*; finger cups, *e*; custard cups, *d*, *e*; cruet glasses, *f*, *g*, *h*, *i*; tumblers, *k*, *l*; wine-glasses of various kinds, *m*, *n*, *o*, including those of green glass; butter basins, *p*, *q*; *s*, salad basins, &c.

Fig. 496.



CHAPTER XVII.

ON PLATE.

Sect. I.—General remarks.

1379. There are very few domestic establishments in which the expense of plate does not form a considerable portion of that of the furniture; and much judgment is required in selecting it. Plate includes all those articles which are made of the precious metals; table services of all kinds, spoons, forks, desert knives, ladles, fish slices, candlesticks, snuffer-stands, bread-baskets, waiters, &c. Our object will be to convey a just idea of the relative value and qualities of articles of this kind executed in various materials, by treating, in a general way, of their manufacture.

In the highest classes of society whole services of gold and silver are used; and in almost all families there are certain articles of table furniture made of these metals; but the arts of gilding and plating are now executed in such perfection, that much expense is saved by resorting to substitutes with little loss of appearance. We shall first treat slightly of the business of the goldsmith.

Sect. II.—Goldsmith.

1380. *The Goldsmith* is the artist who makes vessels, utensils, and ornaments in gold

and silver; for he at present sometimes includes the silversmith. In London he employs several persons under him for the various articles of his trade; the jeweller, the silver turner, the gilder, the burnisher, the chaser, the refiner, and goldbeater, are all employed by him. Formerly, before glass was so abundant and so beautiful, drinking vessels, made of the precious metals, were much more in request among opulent persons than at present; and there was a prevailing taste for massive silver tankards and cups, which extended even to the taverns to such a degree, that, in 1696, the use of silver plate (spoons excepted) was prohibited in those places. During the middle ages the goldsmiths were persons of great importance; they were the only bankers of the time, and it was through their agency that sovereigns and their opulent subjects transacted pecuniary business with one another. Many of them excelled greatly in the fine arts; of whom the celebrated Tuscan, Benvenuto Cellini, was a remarkable example. It is difficult to conceive the vast amount of the precious metals laid up in churches during this period, in the form of statues, sacred vessels, and votive gifts.

1381. *Articles made of gold are ornamented in two ways:* either by designs cut into the work, and called *engraving;* or by making the ornaments rise above the surface *in relief.*

1382. *Engraving on gold* was practised at a very early period, particularly in Italy; and it is a remarkable fact that it was this kind of engraving that gave rise to the art of producing prints by engraving on copper; but it was long before it occurred to any one, that by filling the lines so engraved with a thick ink, and pressing them upon paper, an impression or print could be produced; and it was accident alone that gave rise to this valuable discovery.

1383. *When ornaments were to be in relief,* they were at first cast in moulds; and we find the terms molten and beaten gold used by writers of antiquity, denoting that the processes of casting and hammering were employed in working this metal.

Articles are very rarely, however, now cast in solid gold, owing to the great shrinking that takes place on the cooling of the metal in the mould, in consequence of which it is difficult to obtain that sharpness of impression that is desirable; as well as the great expense of the metal. The most usual method is to roll out the gold into thin plates, and to strike up the figures in relief from behind. This process is termed *chasing* or *embossing,* and is a very ingenious part of the goldsmith's art; to which those of former times were much indebted for the perfection of their works. The vessels upon which it was employed were of extraordinary value; and, when these were executed in the first style of art, excited universal admiration. Fine examples of these may be seen in the superb table services of the British sovereign, and in those of the various princes of Europe, as well as in many private hands, especially in the plate repositories of goldsmiths.

1384. *To perform the embossing,* the body of the design is bulged out from the inside by the application of a hammer; the vessel is then filled up with a composition of pitch and ashes, and rested upon a sand bag. The parts to be sunk, in order to produce the detail of the design, are struck by a hammer and little steel punches; and if any parts are required to be raised, they are struck up from the inside. By this simple mechanism, the various parts of figures, foliage, landscape, &c., are represented with the greatest exactness. It is said, however, that this art has declined, or, at least, that few can be met with at present in this country who excel in it.

1385. *Gold is so soft a metal, that it is scarcely ever used in its purest state,* from its liability to wear; it is therefore hardened a little by an alloy with other metals. But this alloy would be carried to excess, were every one permitted to add as much as he pleased, and it would then be very difficult to determine the actual value of what was called gold; the quantity of alloy is therefore restricted by law.

1386. *Goldsmiths usually indicate the purity of gold in the following manner:* They suppose each article divided into twenty-four parts, which they call *carats;* and if it is pure gold, they say it is gold of twenty-four carats; but if there is any alloy, then this is deducted from the whole. Thus, if one twenty-fourth of alloy is added to twenty-three parts of gold, they call the mixture gold of twenty-three carats; if this mixture contain four parts inferior metal, it will be gold of twenty carats; if it contain six, it is of eighteen carats fine.

1387. *Plate is not legally sold as gold or silver, except it be of standard purity;* and to ascertain this, it is examined by the assay master of the Goldsmiths' Company, whose business it is to test all works in the precious metals, that the public may not be defrauded. If they are found to be sufficiently pure, they are stamped with the proper mark. The purity of gold may be tried by chemical analysis, but a shorter method is resorted to for the purpose. It is sometimes determined by the touch-stone, which is a black flinty slate. This is founded upon the fact, that a mark made upon this stone, by rubbing a metal upon it, has a colour peculiar to that metal; and the colour of the mark made by pure gold is different from that made by any of its alloys. Pieces of pure gold are kept, called touch needles; and others are likewise kept made of alloys in various proportions, and, by comparing the colour of the marks made by them and by those of any article to be examined, its degree of purity is determined.

1388. *In purchasing gold articles of any kind, therefore, it is necessary to see that they bear the stamp of the Goldsmiths' Company.* With respect to many ornaments made and sold by jewellers without the proper stamp, and called *gold*, they contain only a portion of that precious metal, having as much alloy as jewellers can possibly add without losing the appearance of gold; and *jewellers' gold*, as this is called, looks very well when new, but frequently soon tarnishes, which real gold never does. The colour of pure gold is given to this alloy by a certain process, called by the jewellers *colouring*, by which, after the articles are manufactured, the base metals are destroyed at the surface by an acid, and the gold alone is visible: when this superficial gold wears off, as it will in a little time, the articles now tarnished may undergo the process of colouring a second time, by which the gold colour is restored; and even a third time, if the thickness of the article permits the action of the acid by which the restoration is effected, which is not always the case with ornaments such as chains, ear-rings, &c. Dr. Macculloch states that the process of re-colouring may be effected by any person without going to the goldsmith; the method is, boiling the article in a solution of pure ammonia instead of the acid the jewellers use. It is to be observed, that such articles as are made only of jewellers' gold, and not stamped by the assay master, not being of standard purity, are, of course, always of inferior value to those of the mint standard, or that of gold coin, which has only an alloy of two parts in twenty-four, whereas jewellers' gold has an alloy of from that to six parts in twenty-four.

1389. *The gilding of metals* is effected in various ways. Iron is gilded by polishing its surface, and then heating it till it has acquired a blue colour. When this is done, leaf gold is applied, slightly burnished down, and exposed to a gentle fire, after which it is burnished again. Copper or brass may be gilded in the same manner. Gilding metals by amalgamation is effected by forming the gold into a paste, or amalgam, with mercury, and is chiefly employed for gilding silver, copper, or brass. The metal being well cleaned, is dipped into the amalgam, or spread over with it, when a quantity will adhere to the surface. The metal is then exposed to the heat of a furnace, which volatilizes the mercury, leaving the gold adhering; this is afterward burnished. In this way buttons and similar articles are gilded.

Ornamental figures may also be delineated in gold, upon steel, by a very ingenious process, by means of ether. Gold is dissolved in nitro-muriatic acid, and a quantity of ether is added, and the mixture shaken. The ether will then take the gold from the acid, and an ethereal solution of gold will be produced, which is separated, and applied to the surface of the steel by a camel's hair pencil; the ether will evaporate, leaving the gold on the surface of the steel. The metal is then heated, and the gold burnished. In this way sword blades are ornamented. Instead of ether the essential oils may be used.

1390. *Making gilded trinkets is now brought to such perfection*, particularly at Birmingham, that the use of real gold is very much diminished. The most elegant patterns are struck in thin copper, sometimes in London, and sent to Birmingham to be gilded, whence they return, so as not to be distinguishable, in a general way, while new, from gold, and, with care, they will last a considerable time; but, when the gilding does wear off, the colour cannot be restored as in jewellers' gold; they must be re-gilded, which is seldom or never worth the while.

1391. *Lately a new process has been discovered, by which gilding may be performed by means of electricity* with the greatest facility, and by which the workmen will be freed from the unhealthiness attending the process of amalgamation.

Electro-gilding and plating is one of the most interesting discoveries of the present time. When a current of electricity is made to pass through a solution of a metallic salt, the salt is decomposed, the metal passing to the negative, and the acid or solvent to the positive pole of the galvanic battery. By means of this principle, it is found possible to coat a metal with another by plunging it into a solution of the latter, and employing a galvanic apparatus. Thus copper, iron, and several other metals, can be coated with zinc, and likewise with silver and gold, and that in the most perfect manner. The advantages of electro-gilding and plating are so considerable, that they bid fair to supersede every method hitherto employed, and may be seen by a visit to the depôt of Messrs. Elkington and Barratt, in Regent-street, London.

1392. *Gold wire* is, in fact, a silver wire gilded. It is made as follows: A small, cylindrical rod of silver is gilded, and afterward formed into wire by being drawn successively through a great number of holes in a steel plate, each smaller than the other, until it becomes no thicker than a hair. This furnishes a remarkable proof of the ductility of gold; for, although the wire is drawn out to an amazing degree of fineness, yet it keeps firmly together, and the whole of the silver remains perfectly covered. When it is required to be spun into cloth, stuffs, laces, &c., this wire is flatted by steel rollers. Six feet of the finest gilded wire weighs only one grain; and the gold is not quite $\frac{1}{37}$ of the whole. A single grain of gold is thus extended to 345 feet.

1393. *Gold thread* is this flattened gilded wire wrapped or laid over a thread of yellow silk, the circumvolutions of the wire just touching each other so as to cover the silk

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completely. Some make a flattened wire, gilded on one side only, for this purpose. A gilded copper wire is also made for this use. The Chinese, instead of flatted wire, use slips of gilded paper, which they interweave in their stuffs, and twist upon silk threads.

SECT. III.—SILVERSMITH.

1894. *The beauty of silver occasions it to be much employed in furniture*, and the same observations which were made with respect to the manufacture of gold apply also to works in this metal. Articles which experience much wear are sometimes, and often most economically, purchased of solid silver.

1895. *An important branch of the business of the general silversmith* is the making of silver ladles, spoons, forks, sugar nippers, &c., which forms an independent branch of trade. These articles are mostly manufactured in London by manual labour; and, as the intrinsic value of the material constitutes a very large portion of the price, they could not be sold at the usual rate of the metal, but in consequence of the skill acquired by men exclusively devoting themselves to this particular branch. In the wholesale price of gold and silver plate, the workmen's wages and the manufacturer's profits are combined in a single item, always entered as "fashion;" for instance, a dozen of silver teaspoons, intended to sell for £3, would be invoiced thus—silver £2 6*s*. 6*d*., duty 1*s*. 6*d*., fashion 12*s*. Of course, while the value of the material and duty are, in all cases, according to the weight of the article and the current price of silver, the sum charged as fashion will vary exceedingly, according to the quantity and quality of the workmanship. Articles of genuine silver are always stamped as such; but persons are frequently deceived by seeing a stamp on them, somewhat similar, though not identical with the true one.

1896. *The following is a list of the usual articles in silver* required to furnish the table:

Dishes and covers.	Fish slices.	Cheese scoops.	Cream ewers.
Table knives and forks.	Trays and waiters.	Knife rests.	Sugar tongs.
Dessert knives and forks.	Bread baskets.	Nut crackers.	Teaspoons.
Table spoons.	Cake baskets.	Grape scissors.	Toast racks.
Dessert spoons.	Decanter stands.	Tea urns.	Butter coolers.
Gravy spoons.	Decanter labels.	Coffee urns.	Snuffer trays.
Soup ladles.	Liquor and bottle stands.	Tea pots.	Snuffers.
Sauce ladles.	Cruet frames.	Coffee filterers.	Candlesticks.
Salt spoons with gilt bowls.	Asparagus tongs.	Sugar basins.	

Fig. 497 is an example of a silver waiter in the present usual style of chasing; half the pattern only is shown. *Fig.* 498 is a richly-chased silver cake basket.

Fig. 497.

Fig. 498.

Fig. 499 is a silver egg-frame. *Figs.* 500, 501 are silver cruet frames; the first richly chased, the other plainer.

Fig. 499.

Figs. 502, 503 are silver candlesticks in the present usual style.

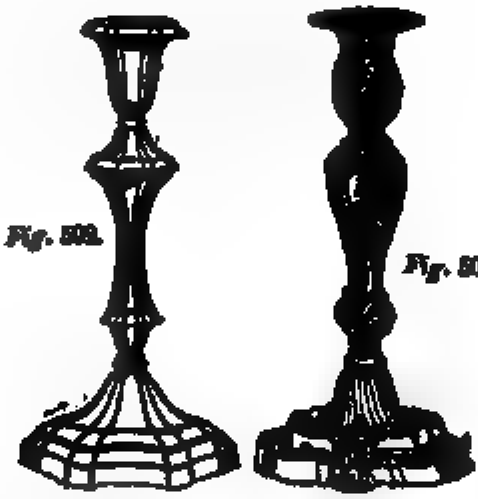
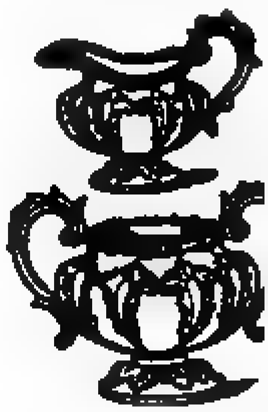


Fig. 502. *Fig.* 503.

1397. *Fig.* 504 is a tea service richly chased, in what is styled by the silversmiths *king's pattern.*



1398. *Fig.* 505 are silver dishes and covers.

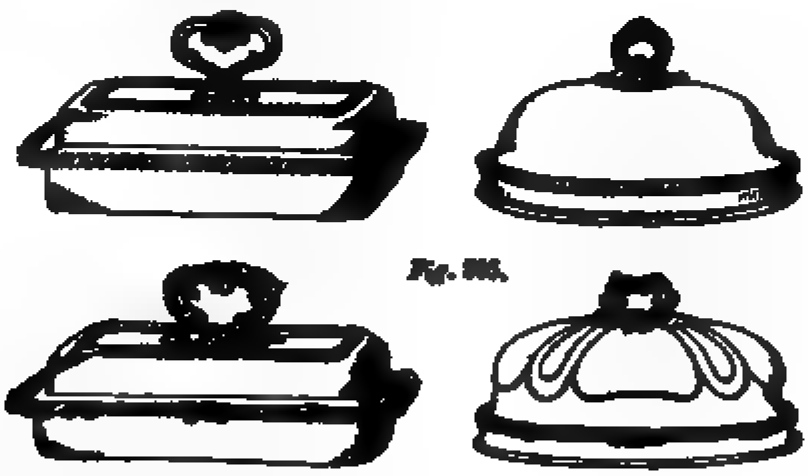


Fig. 505.

1399. *Fig.* 506 *are varieties of silver spoons,* named by the silversmiths, *a,* the *fiddle pattern*; *b, threaded pattern*; *c, threaded shell pattern*; *d, king's pattern.*

1400. *The great price of silver has given rise to the art of plating,* or covering other metals with a thin coating of it.

1401. *French plating* was the first method that was employed, and consisted in burnishing down upon the heated surface of copper or brass articles, after they were finished, successive layers of leaf silver, which thus adhered firmly to the metal beneath, and was polished by the action of the burnisher; but this process was tedious, and it possessed little permanence, from the thinness of the leaves; nor could the joinings of these be always perfectly concealed.

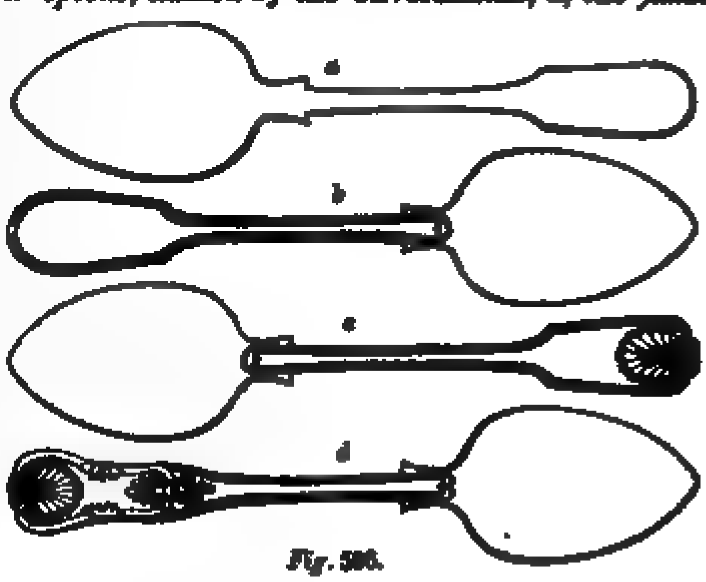


Fig. 506.

1402. *A much superior kind of plating* is now employed in England, and was the invention of a manufacturer at Sheffield, where, and at Birmingham, it is practised to a great extent.

By this mode an ingot is formed of an alloy of copper and brass with a thick plate of silver attached to it, and this ingot is rolled out by a flatting mill to any thinness required, the silver continuing to cover every part of the surface of the extended sheet. Great care is of course taken that no imperfections in the silvering should happen, as these could not easily be remedied. Heat being employed in the process, the two surfaces of the silver and copper are intimately united by fusion, although the temperature has not been sufficient to melt the ingot; for it is known to chemists that an alloy of two metals will melt sooner than either of the metals singly; soldering has therefore been unnecessary. These plated sheets, being now prepared, are cut and hammered into all the forms required, and are stamped, by dies and punches, into a variety of raised ornaments, which are connected together by solder so as to produce the various articles to be made. To strengthen the hollow parts out of sight, they are filled up with solder, so as to give the whole the appearance and strength of solid metal. One of the most usual articles of plated furniture consists of candlesticks; and as the business was, first, to imitate the forms of those which were executed in silver, they were made, at first, with much raised work that had many points and projections. A favourite fashion in these was one of the orders of architecture; but the capitals and square pedestals of this, with the various mouldings, were ill suited for plated metal, as the silver soon wore off the prominent parts, and then they had the shabbiest appearance possible. This occasioned the manufacturers to change the designs; the stems were made plainer, and the bases round or oval, with other improvements more suited to the nature of the material. Still, plated metal did not gain much respect in the world of luxury and fashion till the discovery of making *silver edges*, or of executing in solid silver those parts which projected most, and were most liable to wear; an improvement which added extremely to the durability of the imitation. These parts are made of silver rolled out extremely thin, and stamped; and after the inner sides have the hollows filled with solder, are then bent, and attached to the parts required. It is, indeed, surprising how long plated articles, defended with silver on the more exposed parts, will last when carefully used. *Figs.* 507, 508, 509 are examples of the usual style of plated candlesticks.

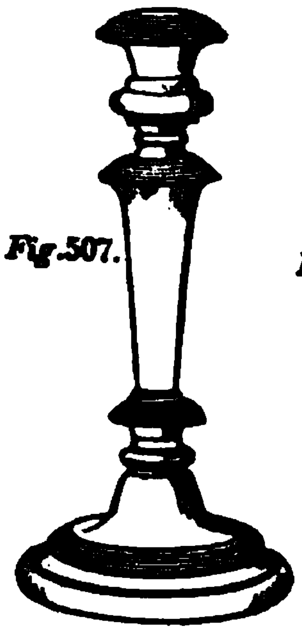
Fig. 507.


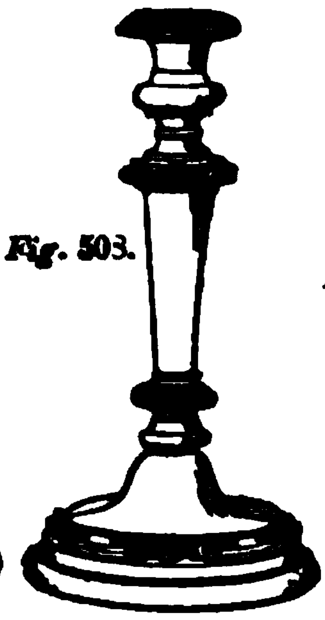
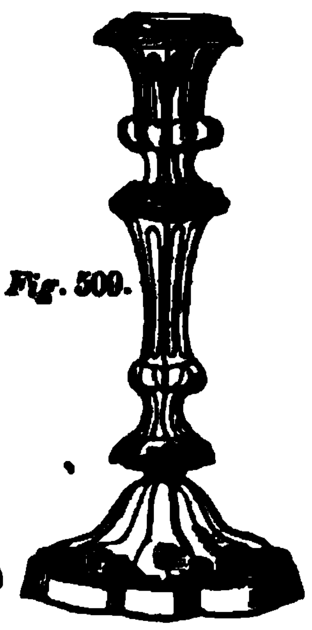
Fig. 508.


Fig. 509.


1403. *When plated goods come out of the hands of the workman,* the metal, though clean, is of a dull white colour, possessing no polish whatever. The last operation is the *burnishing*, which is generally performed by women. The burnishing tools are of agate, or similar hard stones, with smaller ones of hardened steel. Should any accident occur to lay bare the copper in any particular spot, or should the working up by the hammer of any latent blister in the metal produce a similar deformity, the workman has a remedy in the French plating. Having scraped or scoured the place quite clean, and perhaps matted or roughed it a little with a tool, he places upon it a piece of silver reduced to the thinness of foil, and well cleaned: holding the article over a charcoal fire, and directing the heat to the part to be mended, he suffers it to become just red hot, upon which he instantly applies a burnisher to the patch and rubs it for a few minutes, when it will be found to adhere so completely that no subsequent operation of hammering or otherwise will remove it. It is to the burnishing of plate that it is indebted for that rich, lustrous appearance so peculiar to the precious metals. In some silver articles there are parts represented in *matted* or dead work of a fine white ground, and producing a pleasing effect when contrasted with the burnished portions. This effect of matting is produced by covering the subject with a coat of pulverized charcoal and saltpetre, and often heating it until red hot over a charcoal fire, quenching it in a pickle of sal enixon. In some of the very rich and massy pieces of plate, the figures, instead of being stamped and embossed in sheet metal, are cast from designs modelled expressly by celebrated artists in wax, and copied in plaster of Paris. The London gold and silver-smiths sometimes employ first-rate talent in this way.

1404. *When plated goods are to be engraved,* it is evident that, as the depth of the engraved lines would cut through the plaiting and expose the copper, it is necessary to let in a thin plate of silver at the part where the engraving is required; but this is done so ingeniously that the joining is not seen.

1405. *From this description of plated articles* may be perceived the great necessity there

is for avoiding any circumstances in cleaning them that should scratch or rub off the silvering, which is extremely thin, not equal to the finest graved line.

1406. *It is much to be regretted that silver, which is susceptible of so fine a polish, and of which the lustre and the colour are so beautiful, is so liable to tarnish*, an effect which happens to solid silver and silver plate equally. This change is occasioned by the sulphur of the sulphuretted hydrogen gas, a small quantity of which is always present, more or less, in the atmosphere. This sulphur combines with an extremely thin coating of the external part of the silver, thus forming sulphuret of silver, a substance which is of a blackish brown hue. The tarnish can only be removed by taking off the whole of the sulphuret so formed, and therefore a considerable portion of the actual silver of the plated articles is destroyed in removing the tarnish. It is important to understand that the tarnish is not something added to the metal, leaving it as before, but the metal itself changed. The thinnest coating of any substance which may be easily removed, as gum arabic or isinglass, will prevent the tarnishing, by keeping off the air from the surface; and this may furnish a hint for preserving silver in its original brightness when it is necessary to put it away for any length of time.

1407. *While on the subject of plate*, it is necessary again to advert to what has been noticed in the Section of "Materials of Furniture," under the name of *German silver* and *British plate*, respecting which the most extraordinary degree of puffing and quackery is at present practised, and which it is essential that we should guard our readers against. We mentioned that the composition of these alloys is zinc, copper, and tin, and in one called *nickel silver*, it is said there is a little nickel, but no silver. The manufacturers have the assurance to assert that these alloys are quite equal to silver itself; but the fact is, that in their best state they are only equal to badly-cleaned or somewhat tarnished silver, and never equal the beauty of that metal, nor of any metal properly plated with silver. It is true that, being solid, or the same throughout, they do not show any other metal on the edges in wear, as in the case of copper plated with silver, and in some cases, where they are kept well cleaned, they have their use, as far as relates to economy. With respect to their being absolutely free from all deleterious ingredients, we believe this statement to be incorrect, and that the hardest and best of them will be found, on analysis, to contain copper, although the quantity may be too small to cause any alarm as to its use.

1408. *Electro-plating*, the new process of silver-plating by means of the galvanic battery, we mentioned under "Gilding," and it is applied with peculiar success to covering articles with silver, so as to equal the best of the other methods of plating in appearance at least, and at less expense. This method has, likewise, this advantage, that old plated articles, which have been worn so that the copper is exposed, and which could not be replated by any former process, can by this be restored to their first appearance. This may be easily understood by considering the process of Sheffield plating, which is such that the ornaments are forced up after the plating is completed, and therefore fresh silver cannot be applied to them; but in the electro process, the whole, ornaments and all, being merely plunged into the metallic solution, the most complicated enrichments are as easily covered with silver as the plainest work. In electro-plating, new articles, instead of copper as a ground to plate upon, a white, silvery-looking alloy is employed, of the kind called nickel silver, or albata, which, from its white colour, does not appear so much when the edges are worn as copper. The advantages of this mode of plating are so great that it will, in all probability, effect a complete revolution in the art.

1409. *The slight silvering given to certain articles*, as the faces of clocks and barometers, buttons, and similar things, is effected by dissolving silver in some acid, and occasioning a precipitation of it upon the surface of the metal, which is almost always copper or brass. But though some of these modes of silvering look well when burnished, they soon wear, from the thinness of the coating of silver. The silvered faces of clocks will not bear cleaning, and therefore they are varnished. A slight mode of silvering, sufficient for some purposes, as the engraved breast-plates for coffins, is produced in the following manner: two parts of silver powder precipitated from a nitric solution of common salt, one part of alum, and two parts of cream of tartar. These ingredients are made into a sort of paste with water. After cleaning the copper thoroughly, this paste is rubbed upon it by means of the finger covered with soft leather or fine muslin. When the piece is sufficiently whitened, it may be polished by the application of a buff powdered with calcined hartshorn or a little Spanish white.

1410. *The prodigious increase of the quantity of plate manufactured in England* is a striking proof of the progress of luxury. In 1828 (according to a statement made by Mr. Huskinson in the House of Commons) the essay duty on plate amounted to £105,000 for 17,790 lbs. of gold and 1,186,973 lbs. of silver manufactured into plate in one year. This is four times the amount of the precious metals manufactured in France, and is reckoned even equal to one third of all that is manufactured in Europe.

[The manufacture of silver plate in every variety of pattern and finish is conducted in the United States on an extensive scale, which is annually increasing. To such per-

fection has this art been cultivated in America, that very little silver plate is now imported, and of late the patterns of table articles introduced by silversmiths in this country have been imitated and adopted in London, as superior in taste and elegance to those of British manufacture.

The style for silver cups, dishes, and other fashionable articles for table use, which is usually known as the *square* pattern, and by which they are made to assume hexagonal and octagonal forms, &c., was first introduced at the extensive manufactory of Gale, Wood, & Hughes, of New-York, who are among the largest houses in the trade in this country, and who are favourably known in Europe. This American pattern, a decided improvement upon all the old English styles, is now found to grace the tables of the nobility, and even royalty itself, in the mother-country.

Silver spoons, which are found in almost every family in America, constitute an article of very extensive manufacture, and some fourteen years since, Mr. Gale, of the firm just named, invented and patented an improvement in their manufacture, by which they can be afforded at a much lower price than formerly, which has resulted in bringing silver spoons into almost universal use. His patent is now expired, and the improvement is in general use both in Europe and America.

The absence of any general law for assaying the precious metals in this country is felt and deplored both by the respectable venders and the purchasers of plate. The stamps usually found upon articles of silver or gold are nothing more than the initials of the manufacturer, and upon his integrity alone can reliance be placed as to the purity of the metal, there being no assay duty, nor sworn assayer to prevent frauds. Nor do the stamps upon silver plate give any indication of their relative purity, all the degrees of alloyed metal being stamped alike. So also with articles manufactured of gold; though these are often marked twenty-two carats fine, yet, when subjected to the touch-stone, or exposed to analysis, great frauds are often detected, and for which there is no legal remedy. The only safety for the purchaser in silver or gold plate is by selecting a manufacturer whose reputation affords a guarantee against wilful deception.

Whether the policy of imposing no restriction upon debasing the precious metals in the manufacture and sale of silver and gold plate is wiser than the strict inquiry and rigid examination by assayers, as in the countries of the Old World, it is perhaps not easy to decide. The absence of legally appointed assayers may be compensated in part, by both the vender and purchaser agreeing to subject the articles to the examination of some skilful artificer worthy of confidence; and hence there are found in most of the American cities gentlemen who devote themselves to the private business of assaying, whose certificate and stamp are sought by those who are particular as to the purity of their plate.

The amount of plate manufactured in this country for home consumption and exportation is very large, but there being no assay duty, it is impracticable to ascertain its extent with any degree of accuracy. Hence no comparison can be instituted with the amount manufactured in other countries.

Silver plating is not practised in America to any great extent, for the market is well supplied with silver plated ware from the manufactories of Birmingham and Sheffield, which are sold here cheaper than they could be made. The new arts of electro-plating and gilding have been introduced, but are not likely to come into general use.]

CHAPTER XVIII.

ON CUTLERY.

Under the head of cutlery are comprised all cutting instruments of iron or steel, as knives and forks, scissors, razors, &c.

Sect. I.—Knives and Forks, with Various Cutting Instruments.

1411. So familiar are we at present with the use of knives, forks, and other implements for cutting up and assisting us to eat our food, that many persons have little idea how modern are these inventions; and it is curious to contemplate what must have been the condition of society before they were in common use. The history of knives and forks alone would furnish matter for an interesting essay; we can only touch upon a few points that may tend to fix in the mind the relative importance of this portion of domestic furniture. If we look to those insulated tribes, now few in number, that have not yet acquired the use of metals, we perceive that their knives are formed of sharp splinters of certain stones, and of shells. Selected splinters of flint, and particularly of obsidian, have sharp edges; and, when fixed in handles, make cutting instruments much better than might be supposed by those who have not seen them; they are, however, very far inferior to those of iron in point of strength and durability, being extremely brittle, and incapable of being sharpened—for it is only the natural thin edges of the splinter that will serve to cut. These were the sole cutting instruments in possession of the in-

habitants of the numerous islands in the Pacific Ocean previously to their discovery; and from the remains of spear heads, called *Celts*, made of flint, dug up in Britain, the aborigines, whoever they were, had not, in all probability, the use of iron.

1412. *Iron, although the best material fitted for the purpose of making edge tools, and now the cheapest and most abundant of the metals, was not the first employed.* It is never found in the earth in its metallic state, like some other metals, as gold, silver, and copper, and the art of extracting it from its ores is one that supposes a considerable advance in civilization. Copper, hardened by tin, and various other kinds of brass and bronze, appear to have been the materials of which all the warlike weapons and instruments for domestic purposes among the most ancient Greeks were formed. In the description of the Trojan war by Homer, no mention is made of iron or steel; but the swords, javelins, and armour were of brass; and it has hence been doubted whether iron was known in Greece at that period. We find, however, that the Romans were, from the first, not only possessed of iron, but that they at an early time made knives of that metal for carving their meat, and among them the office of domestic carver existed in great families as in later times.

1413. *Among modern nations, England seems to have been* pre-eminent in the manufacture of knives, and though previously to the reign of Elizabeth many were imported, yet then London was the place where the best cutlery was made, although some other towns, as Sheffield, Woodstock, and Salisbury, were its rivals. The most ancient kind of knives were of the sort called *case knives*, having the blade stuck in the handle like desk penknives, and which require to be kept in a sheath. Coarse knives of this kind, termed *whittles*, were manufactured at Sheffield in 1575, and were sold at the low price of one penny; and at this time and earlier, that town was celebrated for its cutlery. At what date the simple and effective contrivance was invented by which knives are made to shut, as clasp knives and common penknives, does not appear; but they are mentioned, in 1650, as having handles of iron covered with horn, tortoise-shell, &c.

1414. *Forks are a much later invention than knives.* According to Professor Beckman, they were probably first used by the Italians about the end of the fifteenth century. They were unknown to the ancients, none being met with among the furniture of Herculaneum and Pompeii; and the Chinese, to this day, use two small sticks, something like a cedar pencil, called *chop sticks*, for picking up the morsels of meat from the plate. Before the use of forks in Europe the fingers were often made to perform the service now rendered by them so much more readily, as well as decorously. The use of forks was, at first, considered by many an unnecessary luxury, and as such they were forbidden in certain convents. At first they had only two prongs of iron, but now have frequently three, and in a certain kind derived from the French, called *spoon forks*, they have four or five prongs, and these are always of silver. The first necessity for the use of a fork would probably be felt by the carver, and the oldest carving fork known, belonging to Henry IV. of France, is still preserved in the castle of Pau. It is of steel, has two prongs, and is of length and strength sufficient to secure a baron of beef.

1415. *The earliest distinct mention of the established use of forks* occurs in a curious passage of Coryates' "Crudities," a singular book of travels published in 1611. The author says, "Here I will mention a thing that might have been spoken of before in the discourse of the first Italian towns; I observed a custom in all these Italian cities and towns through which I passed that is not used in any other country that I saw in my travels, neither do I think that any other nation of Christendom doth use it, but only Italy. The Italians, and also most strangers that are cormorant in Italy, do always, at their meals, use a little fork when they cut their meat. For while with their knife, which they hold with one hand, they cut the meat out of the dish, they fasten their forks, which they hold in the other hand, upon the same dish; so that whosoever he be that, sitting in the company of any others at meals, should unadvisedly touch the dish of meat with his fingers, from which all the table do cut, he will give occasion of offence unto the company, inasmuch as that for his error he shall be at least browbeaten, if not reprehended in words. This form of feeding, I understand, is generally used in places of Italy, their forkes being, for the most part, made of iron or steel, and some of silver, but those are only used by gentlemen. The reason of this their curiosity is, because the Italian cannot by any means endure to have his dish touched with fingers, seeing all men's fingers are not alike clean. Hereupon I myself thought good to imitate the Italian fashion by the forked cutting of meat; not only while I was in Italy, but also in Germany, and oftentimes in England since I came home; being once quipped for the frequent using of my forke by a certain learned gentleman, a familiar friend of mine, one Mr. Laurence Whitaker, who in his merry humour doubted not to call me at table *furcifer*, only for using a forke at feeding, but for no other cause." It would seem, from the foregoing passage, that for each guest to put his fingers into the dish was no "curiosity" in England 250 years ago, any more than it is at present in Turkey and all parts of the East. We read still in the accounts by travellers of Arabian manners, of the host expressing his attention to his guests by helping them with his fingers to choice morsels of meat, even from his own plate.

1416. *The most ordinary and cheapest table knives* are made of common steel; *but the best table knives* are made of *shear steel;* and the words "shear steel" are generally stamped upon the blades. The tang, or part that goes into the handle, is made of iron welded to the steel blade, which, when finished by the smith, is heated red-hot, and plunged into cold water to harden it. It is afterward tempered down to a blue colour, and is then ready for the grinder.

1417. *Forks are generally a distinct branch of manufacture.* The prongs are first formed by a stamp that cuts them out, and they are afterward filed up, and then hardened and tempered. The forks are purchased from the fork-makers by the manufacturers of table knives, who put them into handles.

1418. *Handles of knives and forks* are made of wood, ivory, box, horn, silver plate, silver, &c. *Stags' horn* makes very durable handles, the surface of the horn being left in its natural state; these are often used for large carving knives. Handles made of the *horn of the ox* are generally dyed black, and ornamented with a great variety of patterns, by means of pressing them between two dies after having been softened with hot water. They are liable to injury from being dipped in hot water, as the grain rises, and completely spoils their beauty. *Bone handles* are made of the shank bone of the ox, and the thickness of the solid part of the bone is never sufficient to make the handles equally thick with those of ivory. Some of the bones are very dense and hard, but they do not keep their colour like ivory. To correct this defect, they are sometimes dyed green. The best handles of knives for common use are made of *ivory;* and the beauty, durability, and comparative cheapness of the material may well recommend it to those respectable tables where silver is not always used. *Handles of wood* are now very little used.

1419. *Handles of table knives are made in two ways,* either by drilling a hole in the handle, and cementing into it the tang of the knife, or by making the handle in two parts, each of which is laid on the sides of the tang, in that case made flat, the whole being riveted together to form the handle; this is called *scale tang.* In the first mode the tang is simply cemented in with melted resin mixed with fine ashes, as in the case of the best ivory handles, where there is no appearance of pins or rivets; or a stronger method is to drill a hole quite through the handles, and to run the tang through and rivet it on the opposite end; this is called *thorough tang,* and is the best for use, as the blade then rarely separates from the handle. There is an improvement made lately called *balance knives;* in those the haft is perforated considerably deeper than is required for the reception of the tang of the blade, and a piece of lead is inserted in the bottom of the hole, the blade having, at the same time, a projecting shoulder near the handle. By this contrivance the knife, when laid upon the table, rests upon the handle and shoulder, the blade never touching the cloth, as in common knives.

1420. *To guard the hand against any accidental slip of the knife in carving,* modern carving forks have a very useful addition, which consists of a small spur working upon a spring in the swell of the shank, and capable of being thrown up at a right angle with the instrument, so as to catch the knife should it slip.

1421. *The blades of fruit knives,* instead of being made of silver, are often of steel plated with silver; and these, of course, are much cheaper. In plating these the steel knives are first scoured bright and dipped into melted tin, being, in fact, tinned. Silver foil is folded round it and rubbed down close, and made to adhere by passing a soldering iron over it; after this the whole is exposed to heat over a clear fire to flux the tin. Lastly, the surface is cleaned and polished. Electro-plating will probably be applied to this.

1422. *Forks are now, at the best tables, generally of silver,* except when they are plated on steel, which latter is far preferable in appearance to the British plate or German silver, but does not wear so well.

1423. *Knives and forks are frequently too much worn in the cleaning by the common method.* A lathe and wheel, charged with knife-cleaning composition, would insure a saving of time in the proportion of five-sixths; that is, an hour's work might with this machine be done in ten minutes, and, if care be used, with less wear.

1424. *Knife sharpeners.*—Every person accustomed to carving must have felt, upon occasion, the great inconvenience of a blunt knife, and the advantage of one that has a good edge. The common steel used by the butchers is well known; but it is an inelegant instrument to be seen at table, and requires great dexterity to use it effectually. Several attempts have been made to invent a method of sharpening a knife expeditiously, and without producing any annoyance.

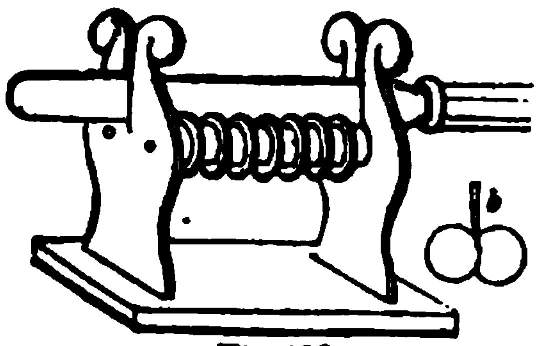


Fig. 510.

1425. *Felton's patent sharpener* consists of two steel cylinders, placed parallel to each other, and revolving upon their axis. Each cylinder has projecting rings of hard steel, the edges of which are grooved finely. The edges of the rings in the opposite cylinders overlap each other a little, as at *b, fig.* 510, by the rings of one cylinder falling between

those of the other. If the edge of a knife be drawn from hilt to point between the cylinders at their junction, a good edge will be given to it by the action of the sharp grooves on the rings, which act like a file.

1426. *Westby's knife sharpener* differs from the last in consisting of two sets of straight bars opening to an angle, and having the insides grooved like a file: the knife to be sharpened is drawn between them, like the last.

1427. *Scissors.*—The beauty and elegance of polished steel is displayed to great advantage in the manufacture of the finer kinds of scissors. These are made of the best cast steel, and are very highly polished. Frequently they are curiously and beautifully ornamented by blueing and gilding with studs of gold, &c. Often the handles are of mother-of-pearl. The shanks of scissors are frequently ornamented with rich open work, or embossed figures, elegantly executed. Some of the filigree shank scissors at present in fashion are wrought with great labour and ingenuity, often occupying an industrious workman two or three weeks upon a single pair in boring and filing out the design.

The blades are made separately, without any regard to their being in pairs; they are afterward filed and paired. Very large scissors have their blades only of steel. Of late vast numbers of scissors of low prices have been made of cast iron instead of cast steel; and many of them do sufficiently well for common purposes, but are not to be depended upon either in their material or workmanship.

1428. *Shears* differ from scissors in being made of one piece of metal only, the two blades being connected together by a strong spring bent like a bow, whereas scissors consist of two pieces of metal moving upon a pin as a centre. The spring of shears causes them to open, and the force of the operator is only employed in shutting them to cut. They are used in various operations, such as clipping the fleece from the bodies of living sheep. We shall say nothing of such shears as are used for dividing sheets and bars of metal, some of which will cut through a piece of iron half an inch thick.

1429. *Penknives.*—A good penknife is an article of such indispensable necessity with almost every individual in civilized society, that it is no wonder uncommon pains have been taken for the attainment of perfection in its manufacture. They are made nearly in the same way as table knives, but should be of the best cast steel. Some are let into hafts for desk knives; others are made to shut, as clasp knives; and one, two, three, or more blades are included under the same handle, even to the knife with a hundred blades, which is a mere curiosity. Besides the goodness of the blade, something depends upon the form and size of the handle; if this be too large, the knife will be clumsy and unmanageable; while, on the other hand, if it be too small, the user will want that proper command of the blade which is essential in the dexterous and successful cutting of a quill. In general, a handle rather fuller in the hand than those of most of the fancy knives will be found preferable for use. If the blade be too broad, it will not effect that graceful curve required in the pen; and it appears to be a good way to make the under side of the blade next the pen a little curved or rounded, that it may turn easily. In the handles of penknives still more scope is afforded for the exercise of ingenuity than in those of table knives; stags' horn, black horn, mottled or white horn, tortoise-shell, mother-of-pearl, are the most frequent substances employed, and endless are the forms and modes of decoration, suited to all wants and all prices.

1430. *The best cutlery is manufactured in London,* chiefly by surgical instrument makers. They employ superior workmen, and reject, during any part of the process of the manufacture, such articles as, from slight flaws, cracks, or even any inferior quality in the steel, may be objectionable. Greater attention is likewise paid to the quality of the steel, and to the accuracy of hardening and tempering it. Although very many excellent articles of this kind come from manufactories in the country, what is town-made is most to be depended upon.

SECT. II.—OBSERVATIONS ON SHARPENING CUTTING INSTRUMENTS IN GENERAL.

1431. After the blades of cutting instruments have been formed, an edge must be given to them; and the same process must be performed, should that edge have been entirely destroyed by use or accident. The first operation is grinding by means of grindstones, coarser or finer, adapted to the nature of the various articles to be ground. Grindstones are made of a grit sandstone, and the best come from Newcastle, and from Bilston, in Staffordshire. The edge given by the grindstone is exceedingly rough; and although it may serve for many coarse purposes, it is too uneven for the nice cutting tools, and therefore a smoother edge must be obtained by a finer grindstone, and then by setting on a *hone.* Hones are of different kinds, for grinding down quickly, or for giving a very fine edge. Of the former is the Turkey stone, which comes from Smyrna, much used in sharpening carpenter's tools; as also the Ayr stone, and a few others, found in N. Wales and Devonshire. The best hone we have for giving a fine edge to razors and similar instruments is the *German hone,* a cream-coloured stone that comes from the slate mountains near Ratisbon, in Germany, and is sent all over Europe. Oil is generally used in setting, but those who dislike the dirt of this may use

soap and water with the hone, which answers nearly as well as oil, and is more cleanly. A certain dexterity is essential in attempting to give an edge on the hone, which it would be vain to describe in words; and we would therefore recommend any one wishing to acquire the power of setting their own razors or other tools, to see the process performed by one who has skill.

SECT. III.—REMARKS ON POLISHING METALS.

1431.* *The following remarks upon the polishing of metals* are given, not so much from their connexion with the cutler's business as for their application to various cases in domestic economy. The polishing of metals differs according to the kind of metal and the kind of manufacture; nevertheless, there are some general principles to be attended to as being common to all, of which it may be useful to have a clear idea. All polishing is begun, in the first instance, by rubbing down the surface by some hard substance that will produce a number of scratches in all directions, the level of which is nearly the same, and which will obliterate the marks of the file, scraper, or turning tool that has been first employed. For this purpose coarse emery is used, or pumice and water, or sand and water, applied upon a piece of soft wood, or of felt, skin, or some similar material. When these first coarse marks have been thus removed, they next proceed to remove the marks left by the pumice-stone by finely powdered pumice-stone ground up with olive oil, or by finer emery and oil. In some cases, certain polishing stones are employed, as a kind of hard slate, used with water. To proceed with the polishing, still finer powders are used, as Tripoli and rotten-stone, which is still finer, and is found only in Derbyshire. Putty of tin and crocus martis are also used for high degrees of polish. But the fact is, in respect to polishing, that the whole process consists merely in removing coarse scratches by substituting those which are finer and finer, until they are no longer visible to the naked eye; and even long after that, if the surface be examined by a microscope, it will be seen that what appeared without any scratches is covered all over with an infinity of them, but so minute that they require a high magnifier to be discovered. The operator, therefore, who understands this principle, will know how to vary his polishing substances according to the nature of the article he wishes to polish. It is quite evident that his polishing material must be able to scratch, in a coarser or finer manner, the substance he is desirous of polishing, for wearing down is only effected by producing minute cuttings or scratches. It is evident, also, that great care must be taken to have the last polishing material uniformly fine, for a single grain or two of any coarse substance mixed with it will produce some visible scratches instead of a perfectly polished surface.

See remarks on polishing materials in Sect. XVII., Book V.; the coarsest being emery, sand, glass-paper; the next in degree, brickdust, washed emery, Tripoli; and the finest, rotten-stone, whiting, or chalk, putty of tin, and black-lead. Oil is generally used in giving the highest degree of polish, and the greatest care is necessary to prevent any of the coarser particles getting mixed with the finishing powders.

BOOK VI.

ON THE ESTABLISHMENT OF HOUSEHOLD SERVANTS, AND THEIR DUTIES.

CHAPTER I.

CONDITION OF DOMESTIC SERVANTS, AND THE OBLIGATION OF THEIR SERVICE; THEIR QUALITIES, ETC., CONSIDERED.

SECT. I.—CONDITION OF DOMESTIC SERVANTS.

1432. *Domestic servants are a class in society* no less essential to its welfare and convenience than the equivalent in subsistence and money which, for service done, that class receives, is essential to the well-being of each individual belonging to it.

1433. In no era of time, nor in any state of social life, has man been able to dispense with the aid of his fellow-creatures without losing ground in his progress towards civilization. Mutual assistance, co-operation among men, is the impetus to social improvement, the promoter of social convenience. So great has the necessity for it ever been, that, in countries and in periods in which this could not be the effect of mutual compact, the stronger members of communities imposed it by force on the weaker; and hence the origin and wrongs of slavery.

1434. Very different from slavery is the condition of domestic servants at the present time in most parts of the civilized world. It is respectable and creditable. It has its rights, its privileges, which give it a character of independence, notwithstanding

the term "service" attached to it. Public laws protect this class of the British community from injury and oppression, and the prevalent domestic regulations and habits all tend to secure to it every requisite comfort, and, even more, much enjoyment. Independence, like happiness, is always comparative. There is no class of society but has its power "to will and to do" restricted variously and in different degrees. Each class and each individual composing it is under subordination of some kind or other; and each acquiesces in its necessity, on perceiving it to be based on principles of general utility and security. When subordination is so based, society must be both generally and individually benefited. Without it, what would be the state either of public or private life? The struggles and contentions of ungoverned passions, the clashings of different interests, the wilfulness of the powerful, would assail and overcome all the quiet and peaceful influences of domestic life, and be in perpetual opposition to the order and justice by which society is held together.

1435. Hardships and the loss of independence can scarcely be considered as characterizing, in this country at least, the state of domestic service. If deficient in personal freedom, it is exempt from great anxieties and responsibilities; and in admitting of change from one service to another, it fetters no individual to the permanent endurance of trials peculiar to any one situation. It compels no one to an undue devotion of his strength, nor to engage in any excess of duty beyond that which, on entering a service, he voluntarily, and for a stated compensation, engages to perform. It does, indeed, require from him a diligent and a faithful attention to the duties which he has undertaken; a strict regard to personal decorum, and to the moral obligations of temperance and honesty. Trials of patience and temper he may experience; but not in a greater degree, probably, than his superiors may have, in their sphere, to encounter.

1436. *The principal of a family* has a right to prescribe certain regulations by which his servants are to govern themselves. There can be in different families no complete uniformity in these domestic regulations, while there is neither uniformity nor equality in the circumstances and characters of those who form social communities: in every household some variations of habit and custom must be expected; and servants, entering new situations, will be disappointed if they expect to meet in each a counterpart of those which they had left. They must conform to each variety, or submit to the penalty of frequent dismissal. There can be no proper notion of domestic subordination when a servant permits himself to reproach his employer, and, which is not unfrequently the case, with some such expression as this: "I have never been used to that," or, "that work did not belong to me in my last place." Neither has he any right to object should his master prescribe the mode in which he is to perform his business; and he is especially blameable if, at the same time, he impertinently retorts, "I know my business, and am not come here to learn."

1437. In describing the course of domestic business, the object herein is not to mark the limits of each servant's province, as if he was not subject, in the main, to the wishes of his master, or to the convenience of the family whom he serves; but governed, as it were, by prescriptive regulations, to which, as a code of domestic laws, he may appeal for his justification when inclined to disobey orders given him. On the contrary, the intention of this work is, after setting forth the condition and usual treatment of servants, to present a manual of domestic knowledge and of household practice, to which inexperienced housekeepers and servants may alike refer, when seeking to know the details in each branch of household duty, and the mode in which, in all general cases, household work is distributed throughout the establishment.

1438. The suggestions and details thus brought together may be respectively useful to master and servant, without affording pretext to either for the omission of any part of their mutual obligations, or for any breach in their mutual compact.

SECT. II.—QUALITIES OF SERVANTS.

1439. *In servants, generally*, we look for the essential qualities of *integrity, sobriety, cleanliness*, and *general propriety in manner and dress*, together with the knowledge of the duties in their respective departments of household business which, on being hired, they professed; whence, besides these indispensable qualities and powers, some few members of large establishments should, in order to be competent and effective, have other distinctive marks of fitness for the office filled.

1440. *A house steward*, for instance, the chief member of the establishment, holds the most responsible of the household offices. Of him, as the representative of a higher domestic authority, we would remark that he should, in some measure, manifest qualities similar to those possessed by him whom he represents. Any one having authority over others should have *self-command*, to enable him to meet, without forgetting himself, provocations from the unruly or insolent subordinate members of the establishment. He should possess *firmness* in enforcing all reasonable performance of duty: he should have *integrity* beyond the powers of any one to induce him to connive in deviations from duty or honesty: with these qualities, he should demean himself in such a

manner that none in the subordinate departments of the house should be on such familiar grounds with him as to diminish his authority or influence over them.

A butler is sometimes similarly situated with the house steward, and is hence called upon to exercise similar qualities with those above mentioned.

1441. *The housekeeper*, whose place in the female part of an establishment is similar to that of the house steward among the men servants, should possess the observation and vigilance of an active mistress of a family. Her eye should never be withdrawn from the circle of her duties; in that she should be ever ready to act with the decision, keenness, and interest of a principal, maintaining over the subordinate actors in it a strict but not severe superintendence. Those whom she has to direct, and to keep to a regular discharge of duty, are like children, requiring a firm mind to govern them, a quick apprehension of their dispositions, so as to apply to each an appropriate stimulus to good conduct; and a kind disposition, to afford them comfort and consolation when ill or in sorrow. To sum up the characteristics of a good housekeeper, she should display a propriety of manner which impertinence would not dare to attack, and an integrity of conduct which malignity could not impeach.

1442. *To the lady's maid and valet*, both standing on similar grounds, prudence of speech should belong. It would secure them the confidence of their employers, and save them from the inconvenience and trouble in which indiscreet tattling would involve them. Being more immediately about the person of those whom they serve than others of the establishment, they have opportunities of hearing opinions of persons and circumstances, hastily and unguardedly expressed, which, if repeated, might be mischievous, especially if told inaccurately, or with exaggerations. In these two members of the establishment, it is also apparent that uniform neatness and cleanliness of person, with order in their habits, and the power of controlling their tempers, are requisite qualities.

1443. *Of the head nurse*, the qualifications which appear to be requisite or desirable are so numerous as scarcely to be found united in one individual. Fitness for the important office of nurse must be found in an union of qualities and powers, both natural and acquired.

1444. *In person* a nurse should have no striking peculiarity or deformity. No habitual tricks with the features, such as squinting or grimaces; no defect in the articulation, such as lisping and stammering; no singularity or vulgarity in the tone or accent; for such peculiarities always bring into exercise the imitative propensities of childhood. *In stature* the middle size is, for a nurse, preferable to either extreme of tall or short; the one often causing deficiency in activity, the other in muscular power. *The constitution* of a nurse maid should be sound. Tendencies to humours of any kind, to consumption, to rheumatism, or even being liable to frequent headaches, would detract from the personal fitness of an individual for the duties of the nursery. *In age* the nurse should be neither very old, nor very young; were she old, she might possibly be very deficient in activity and temper; were she too young, she might want consideration and judgment. *In disposition* she should be cheerful, even to liveliness, yet, withal, gentle. Boisterous gayety in the nurse would be almost as injurious to her infant charges as a temper of irritability and violence. In the situation and duties of a nurse there is much to try the temper; and it is not reasonable to expect that it should be always unruffled; still, no one is fit for the charge of children who cannot control in herself any violent expression of irritation.

1445. *In personal habits* the nurse should be scrupulously correct. Cleanliness and neatness are not to be dispensed with in the individual who is to lay the foundation of good habits in the objects of her superintendence. Deficiency in such habits can, in her, only arise from indolence; and if this defect be inculcated in childhood, by the force of her example, it may, being the parent of so many other vices, blight the promise given in the first years of life of the exercise of future mental vigour.

1446. But, after all, no personal nor acquired qualification in the nurse can be put in competition with the all-important requisite of vigorous, effective, and virtuous principles. Neither deformity in person nor singularity of speech or deportment can inflict, on an infant generation, an injury equal to that which a vicious influence in the nursery can effect. The arts of deception and craft manifested there have often sapped the ingenuousness of the most guileless nature that childhood had ever evinced. Such evil once effected, and thus early in life, all hope of honour and integrity being manifested in manhood must be abandoned.

1447. A head nurse, besides being herself scrupulously upright in conduct, should be acutely alive to all habitual deviations from rectitude in the conduct of those employed as her nursery assistants. Should their faults, after a fair trial on her part, prove incorrigible, she should not from false feeling screen them from detection, but, rather, should openly and decidedly make them known to those authorized to dismiss them Their occasional omissions of duty, together with many of the inadvertent errors of youth, may, and ought to be treated leniently, if not entirely overlooked; but any systematic deception, habitual indolence, and violence of temper, any one of which defects

would render their example dangerous in the nursery, it is her decided and peremptory duty to expose. If her employers retain them after knowing their defects, her responsibility as regards them ceases, but as long as she conceals their misdemeanors, she makes herself answerable for the consequences. Let her keep always in mind, that although the conduct of a junior servant may not be as well regulated as that of one who has passed through the discipline of years, yet that it is part of her duty to see that no one over whom she has authority neglects to perform her share of work with neatness, cleanliness, activity, and good humour, nor sets any evil example before those whose infant propensities would render ready imitators. A nurse who acts thus would be entitled to no common share of respect and gratitude from her employers.

1448. *Foot boy.*—Of all the subordinate members of an establishment, such as foot boy, scullion, &c., the good qualities to be sought for in them are of an invariable nature. No one would, knowingly, engage in their service those whose characters could not stand a strict investigation as to honesty, sobriety, cleanliness, activity, and civility. Possessing these qualities, the duties of these inferior members of establishments are so much under the superintendence of those above them among the household that they are on the footing of learners rather than of able assistants in domestic business. Their fitness for the departments they fill must be sought for more in the qualities of which they give indications, and in their promise to improve, than in their efficiency as servants.

SECT. III.—CORRUPT PRACTICES OF SERVANTS.

1449. *Corrupt practices of servants*, which are not unfrequent, must here be noticed as warnings to their employers; in whom such practices are discovered there can be no confidence, for they betray the want of some of those requisite qualities above enumerated. The consequences of such low-minded trickery of which we are about to speak recoil upon servants generally; the good suffer with the bad.

In a household, every instance of pilfering and trickery accumulates odium on the whole class, and makes it individually watched and suspected. The prevailing bad opinion of servants inflicts, too, an injury on the employer and the employed; a suspicious temper being as unfavourable to the character of the one as to live suspected is to that of the other. Yet that there is sufficient ground for suspicion must be allowed. It is every day acknowledged that one of the main anxieties of housekeeping is the apprehension of the dishonesty of those who are under our roof and receiving bread from our hands; it is this insecurity which often destroys repose, and undermines a generous and confiding temper. Were the depredations of a description to be easily detected, the annoyance would be of less moment; but they are usually so systematically small as to defy the strictest scrutiny to discover, and yet so uniformly carried on as to be in the end incalculably great.

1450. *Of these practices, that of connivance* with the servants of the tradespeople employed by a family is one necessary to be known, as the remedy is evident, provided the practice be confined to the servants, and not to the tradesmen themselves. It is that of entering into the books more goods and articles of food than are brought into the house, the amount of which is divided between the cooks and the agents employed by the tradespeople to convey their commodities from their shops to their customers. So prevalent has this malpractice been as to give origin to slang epithets; for instance, the loaves added to the amount of those actually taken into a house are called *dead men's loaves*.

1451. It must, however, be remembered, that if the payment of the baker's bill be not settled between these dishonest parties, they can derive no advantage from the fraud, and will therefore have no inducement to practice it, unless the baker himself also connives.

1452. Against cooks, charges have been often substantiated of other ways of disposing of the provisions of families which they serve. It is indisputable that a traffic is carried on by many cooks with their own needy connexions; and from the discoveries which have been frequently made has arisen the rule of exclusion from every house of the friends and relatives of servants in the metropolis: an indispensable restriction, unless the friends are almost as well known to the family as the servants themselves. In all great towns petty depredators have so many means of evading discovery as to render them the more dangerous.

1453. *In paying bills*, dishonest servants find another means of emolument to themselves at their employers' cost; and in which the tradespeople certainly do connive, probably for the object of keeping in favour with those who, if so disposed, might injure them with their customers. It is no uncommon practice for a cook, on entering a new service, to make terms for herself with the tradespeople of the family, and if they prove unbendingly honest, she has no resource but to decry their goods, and thus lessening their estimation with their customers, induce them to deal elsewhere, and perhaps with persons of her own stamp. One of her claims is to the odd pence and halfpence of each small bill, and to the discount upon large accounts. *Christmas-boxes* are also generally demanded by servants from tradespeople. All these sources of secret gain must, it is apparent, spring primarily from the principals of families, and not from the tradespeople who, in affixing a price to their commodities, must take into account all these drawbacks upon them, or their business could not prosper. These facts do not rest on doubtful authority, but are indisputable, and illustrate the importance and economy of the habit of each principal settling his own bills, and allowing his domestics to have as little concern with his tradespeople as possible.

1454. *The honour which servants* pretend to preserve among themselves, and which prevents them from exposing the frauds and misconduct going on among them, is only another name for deception and dishonesty. An honest-minded servant ought to distinguish between the pettiness of tattling and the duty he owes to his employer and himself; and it should always be impressed on his mind that to see dishonest practices and not to disclose them to the injured party, is to participate in them. He becomes an accomplice, if he knows of frauds and is silent.

SECT. IV.—HOUSEHOLD REGULATIONS.

1455. *In the following details* will be found the regulations, now generally, though variously modified, by which the treatment of domestic servants is governed:

SUBSECT. 1.—*Food of Domestic Servants.*

1456. *The food of domestic servants* is uniformly at the cost of the principals of families, though, in different spheres and houses, there are different modes of settling this part of domestic management.

1457. *One, and the most general plan*, is to have meals prepared for the household distinct from those of the family, at stated and early hours, and consisting chiefly of plain substantial fare, with specific allowances of beer and ale.

1458. *In this country*, but only in families of the first rank and greatest affluence, there are two distinct tables allowed in the establishment; one in the steward's room, for the chief members of the establishment; the other in the servants' hall, for the rest of the domestics.

1459. *The steward's table* has been of late years less frequent than formerly in the houses of the great. During the long war of the last century, provisions became so immoderately high, and every luxury so heavily taxed, as to induce, in most houses where large establishments were indispensable, great retrenchment in whatever way it could be effected; and the first step taken by many of the gentry was the abolition of the steward's table, only one general table in the servants' hall being thenceforward allowed to the establishment.

1460. Where the steward's table is yet extant in the houses of the nobility, the housekeeper and house-steward preside at it, and none of the domestics but lady's maids, valets, butlers, and head gardeners, are admitted to it.

1461. In the housekeeper's room, the same party take their breakfast, tea, and supper, at the last of which the head nurse has a place, when she can leave the nursery without neglecting her charges.

1462. *The meals* in the servants' hall are usually announced to the members of the establishment by the ringing of a great bell. It is rung at 8 o'clock in the morning for breakfast, at half past 12 or 1 o'clock for dinner, and at 8 again for supper. In large establishments, where many are to be served, an hour's time is allowed for dinner. In establishments of smaller number, half an hour is allowed for dinner, and half an hour also for tea and supper.

1463. *Breakfast and supper* for men servants consist generally of bread and cheese, occasionally of meat, together with a pint of beer to each. Generally speaking, *meat* is allowed to establishments only once a day.

1464. The consumption of food sufficient for each domestic has been calculated to be at the following rates:

Allowance of bread for men servants, two quartern loaves each, or 8 lbs. per week; for women servants, one quartern, or 4 lbs. each per week. *Allowance of butcher's meat*, half a pound per head for each day's dinner for females; three quarters of a pound for men. *Allowance of cheese*, one quarter of a pound per week for each individual. *Allowance of butter*, if fresh, half a pound per week for each servant, or if salt butter be used, three quarters of a pound. *Allowance of tea*, half a pound *per month* for each servant. *Allowance of sugar*, half a pound per week. *Allowance of beer*, for the men, a pint at each meal; for the women servants, half a pint at each meal.

1465. *Board wages* are, in some houses, given to servants instead of food. Some regard this mode as economical, and as diminishing the trouble of housekeeping. But others consider it as a mode full of temptation to petty thieving in servants scarcely to be resisted, and hence its evils are greater than its advantages.

1466. For servants left in houses when families are absent from home, board wages form both a proper and convenient mode of fulfilling the master's obligation to provide food for them.

Board wages for men vary, according to the circumstances of the family paying them, from twelve to fourteen shillings per week; for *women*, from eight shillings to twelve per week. Servants living on board wages usually club together, and appoint the cook of the family to be their caterer; or, in some cases, the cook contracts with the rest to provide them at so much per head their dinners and suppers. *A third arrangement* is sometimes adopted. Food generally is provided for the establishment, but money is allowed each servant to provide for himself beer, sugar, and tea. *For beer* the allowance in money is two shillings per week for each man servant, and one shilling per week for each female servant. *For tea and sugar*, some families allow one pound per annum to each servant, others two pounds. *Of these modes, the principals of families* adopt that which to each family respectively appears to be most convenient or economical. *Servants* have no choice in the matter, farther than that of declining to serve in families where arrangements of this nature appear to them objectionable, or not conducted in a manner likely to promote their daily comfort.

1467. *The meals of servants* in small families, and of limited means, generally take place immediately after, and upon the remains of, the family meals. In such cases the hours of the family are early and regular, or the arrangement would prove uncomfortable and injurious to the health of servants, whose constant active employments render regularity in their meals of great importance to them.

Subsect. 2.—*Dress of Servants.*

1468. *The dress of men servants* is regulated by the style and rank of the families whom they serve. Great neatness, and even a gentlemanly appearance, are expected at all times in the upper servants, and especially when in attendance on their principals. Whether servants be *in* or *out* of livery, they must, when attending at table, always appear in clean white cravats, and in white stockings, either of cotton or of silk. Men servants *out of livery* provide their own clothes, their wages being proportionally higher than those of livery servants.

1469. *Livery*, formerly the cavalier's badge of devotion to some fair lady, whose livery he assumed at "tilt or tournament," is at present only a mark of service.

1470. Livery, in some families of quality, is a part of the inheritance handed down to them in succession from one generation to another, and generally has some relation to the colours of the arms. Of those who have no long line of ancestry to boast of, the livery is often matter of fancy and choice only, and is costly or plain, according to the style, fortune, or taste of each family, and on whom, and not on the servants, the charge of providing it falls.

1471. A livery consists of a complete suit of clothes. The allowance of suits in the year to each servant varies, in the different families of genteel life, from two to one suit of dress livery, with one suit of undress clothes, to be worn during the hours of work, or during occasional absences from home of the family. One hat each year is generally provided by the master; but linen, gloves, stockings, and shoes the livery servant provides for himself. He also pays for his own washing, with the exception of his linen, jackets, and aprons, which are usually sent to the laundry to be washed, or with the family linen.

1472. At tables where style is kept up, servants are expected to attend in silk stockings, and with either silk or white kid gloves. In such houses the wages are, or ought to be, proportionally high. The use of

gloves in waiting at table has superseded that of the table napkin wrapped round the hand of the servant employed in presenting articles to those at table. Neater in appearance, and less troublesome to the waiter, the use of gloves may be regarded as an improvement on the old fashion; but it is somewhat more expensive to the servant.

1473. For the rough business which footmen undertake to do, when they enter families where only one man servant is kept, the master usually provides his footman with a coarse jacket and large trowsers, which cover over the whole of his dress. Jackets of linen, or coloured cottons, and white aprons, are also allowed him, in which he may, without impropriety, answer bells in the morning. In this dress he usually performs much of his morning's work, and dresses himself either before luncheon, or before the dinner hour.

1474. *A coachman* has one livery, also two hats, and two pairs of boots, allowed him annually, and a box coat once in three or four years; also one or two stable dresses, consisting of *rowels*, a jacket, a waistcoat, and one undress frock-coat.

1475. *The under coachman* has nearly the same allowance of clothes. *To grooms* are allowed yearly two suits of livery and two stable dresses. To postillions three sets of jackets in two years, and a cap yearly.

1476. *The dress of female servants*, although usually left to their own discretion, may be, and generally is, influenced by the opinion of their employers as to its suitableness and consistency. A mistress may require her maid servants to expend a portion of their wages on neat and creditable clothing. Beyond this she may have no right to interfere; but by a judicious use of her influence she may restrain them from running into extravagance and inconsistency of dress, and, consequently, from many errors into which their vanity might lead them. Of late years the low price of most of the articles of clothing has introduced into many classes a more showy style of dress than they formerly indulged in, and among maid servants this is particularly evident.

1477. *Of neatness of dress* all must approve; it is inconsistency, in point of expense, of form, or of colour, with the means or daily avocations of any class of society, that alone is censurable.

1478. In large establishments of servants there are different ranks, as in more general society, in which the avocations vary, from those which are laborious to those comparatively light and easy. In the discharge of these different employments, a different style in dress may be not only admissible, but consistent. *The housekeeper and lady's maid* may, with propriety, approach nearer to the style of dress of their employer than the *house maid, laundry maid, or under servants*, though in all the same general principle should be the guide.

1479. *Cleanliness of dress*, whatever may be their employments, all servants should regard as one of their essential requisites. In the upper servants there can be no obstacle to its observance; the difficulty may be greater with those who engage in the more laborious duties of cleaning a house. Yet with them much depends on habit and management of their work. Some servants have the habit of getting through even the least cleanly part of their employments in a comparatively cleanly manner; with others the reverse is as evident. One servant will scarcely show by her dress, another scarcely hide, the nature of her employments; so great a difference in habits is there even in this one point.

1480. *To the habit of neatness* the same remark will apply. Neatness and cleanliness may indeed be regarded as inseparable qualities, the one being rarely found without the other. The same habit of mind tends to the cultivation of both; and *where* these qualities are found, *there* also we may look for *greater consistency*, for a better taste, it may be called, in dress.

1481. *To the love of finery* are often united habits of untidiness and uncleanliness. It is no uncommon thing to see *slovenliness* among domestic servants in the morning hours, and in the evening a dress inconsistent, both in expense and style, with their station and means.

1482. *In families requiring the attendance of maid servants during the morning hours* in the parlour, or at the house door, the neatness of their morning dress is as important as that of the evening, although, from the difference of their employment in these divisions of the day, a change of dress is both allowable and desirable.

1483. *Among the articles of dress* which must be regarded as inconsistent with any degree of domestic service may be enumerated silk gowns and silk stockings, blond, lace, feathers, and artificial flowers, bracelets, necklaces, rings, and ear-rings. Will it be considered as entering too much into particulars to mention with censure the common mode with which maid servants dress their hair? In the morning they are disfigured with tiers of curls in paper; in the afternoon sometimes decorated with long pendant ringlets, to induce which much time is bestowed at night, when, if rest be not needful to them, they might be better engaged in repairing their clothes. A servant of correct taste in dress would never appear in curl papers, nor keep her hair of such a length as to require more than very simple curling.

1484. The outlay in dress the wages of each servant should regulate. Those who have low wages will not, if they reason rightly, attempt to vie in dress with those who have higher wages. Propriety and prudence alike condemn such attempts in them, as much as in the wife and daughters of a man of small income, were they to compete in dress with those of superior means.

1485. *In servants' dress two thirds of the wages only* should be spent. The remainder, left in the hands of their principal, or placed in saving's banks to accumulate, may prove a means of comfort to them beyond comparison greater than the transient pleasure which a more expensive dress might give them. In the following tables will be found estimates sufficiently accurate to show, that with judgment in the choice of the materials, and a proper subordination of the inclination for dress to the means for obtaining it, a third part, or even more, of wages, may, in most cases, be untouched, and yet the personal appearance of the servant not neglected thereby, but rather improved, inasmuch as consistency in dress is always one of its most becoming attributes.

1486. *Tables of maid servants' dress consistent with wages.*

TABLE I.—*Wages £7 7s.*

	£	s.	d.
1 good cotton dress, at 8d.	0	7	8
2 common working gowns, at 6d.	0	7	0
Linings for the dresses	0	2	0
4 petticoats	0	8	0
Body linen	0	4	6
Stockings (3 pairs)	0	6	0
Muslin for caps and handkerchiefs	0	6	0
Bonnet and trimmings	0	10	6
4 checkered aprons, 2 white ditto	0	6	0
A shawl	0	12	0
2 pairs of shoes	0	12	0
2 pairs of gloves	0	1	6
Sundries	0	10	0
	£4	13	2

TABLE II.—*Wages from £12 12s. upward.*

	£	s.	d.
3 gowns (making, &c.)	1	10	0
Petticoats	0	12	0
Body linen	0	6	0
4 pairs of stockings	0	6	0
Aprons	0	7	0
Caps, habit shirts, ribands, and gloves	1	0	0
2 bonnets and trimmings	1	0	0
Shawl	0	15	0
3 pairs of shoes	0	12	0
Sundries	1	0	0
	£7	8	0

SUBSECT. 3.—*Customs and Rules among Establishments of Household Servants.*

1487. In all large establishments of servants one rule invariably prevails. The men and women servants, during the intervals in their employments, are never allowed to sit together in the same room. Each, men and women, have their respective places of resort. At dinner and supper time only do they assemble together. This regulation it is the duty of both the steward and housekeeper to see observed, as experience has proved it to be favourable both to the morals of the individuals of establishments, and to the proper fulfilment of each branch of household work.

1488. *To the housekeeper's room* lady's maids repair for breakfast, tea, and supper, and at all other seasons of leisure. Here, also, butlers and valets are admitted to tea and breakfast, but not at other seasons. *The still-room maid* waits upon the housekeeper and those in her room.

1489. *The steward's or butler's* room is the place of resort for the upper men servants; and, in houses where a second table is still allowed, the dinners and suppers of the chief members of the establishment are served in the steward's room, the steward's boy waiting at table.

1490. *The still-room*, formerly the place in which waters of various kinds were distilled for domestic use, and where the housekeeper still prepares confectionary, and all the sweetmeats requisite for desserts, is also the place appropriated to the use of the female servants who rank below lady's maids. In this room they breakfast and have tea; and to this room, after dining in the servants' hall, they withdraw; and, under the superintendence of the housekeeper, the housemaids occupy themselves there in repairing or making the household linen.

1491. *The servants' hall*, in which both men and maid servants have dinner and supper, is also the place to which all the men below the butler repair, when disengaged from their several occupations. In this place the kitchen maid, and the boy who cleans the servants' knives and forks, wait at table. After each dinner and supper the parties separate, and adjourn, as above mentioned, to the several places appointed for them.

1492. *The nurseries* are the proper places for those who have the charge of the children in them to remain in during the evening. Their attention ought at that period to be given to the repairing or making of children's clothes. Nurses and under nurses always have their meals in the nursery. In some places the head nurse has the privilege of supping in the housekeeper's room, provided all her charges are well and asleep.

Order in which the members of a household establishment rank themselves.

MEN.		WOMEN.	
House steward.	Under butler.	Housekeeper.	Upper laundry-maid.
Valet.	Coachman.	Lady's maid.	Dairy-maid.
Butler.	Groom.	Head nurse.	Under housemaids.
French cook.	Steward's boy	Head cook.	Under laundry-maid.
Footman.	Stable boys.	Upper housemaid.	Kitchen-maid.
		Stillmaid.	Scullion.

1493. In establishments of the highest rank there are grooms of the chamber to be added to the above list. The duty of these individuals is to remain in the ante-room, ready to usher visiters into the drawing-rooms, and to superintend the appropriation of the several bedrooms, place, send off, and receive the trunks, &c., of parties visiting at the house.

1494. *In establishments* where there are neither steward, housekeeper, nor butler, the cook presides at table, and is, in some measure, regarded as responsible for decorum and good order being observed by all seated round it. In such small establishments there would be no use for many of the strict regulations which in larger ones are essential. When there is no servants' hall, the servants take their meals in the kitchen, and sit there also when they are disengaged from their routine of business. Footmen have their pantries, in which, if they have nothing particularly demanding their attention, they can occupy themselves in reading and writing.

SUBSECT. 4.—*Perquisites of Servants.*

1495. *The perquisites of servants* are, in many cases, so many encroachments on the property of their employers, who tacitly allow them, while they, in principle, condemn them. Perquisites are among the circumstances which tend to corrupt the morals of household servants, and as such their continuance is most objectionable. At the same time it would be difficult to eradicate the evil, which is, by prescription, become almost a domestic law. Why it has so corrupting an influence among a household it is not difficult to perceive. It places the interests of servants in opposition to those of masters. What is gain to the one is often loss to the other; and in taking only a short-sighted view of his interest, a servant's integrity is not always proof against the temptation of immediate gain. The barrier between honesty and dishonesty being once broken, who can say how often it will be passed?

1496. *Among the perquisites*, the first that may be noticed as objectionable is that of *vails* or gifts in money from visiters to servants. The custom is a species of bribery for services which ought to be performed without it, and it has a tendency to make servants less attentive than they ought to be towards such visiters as cannot give them great pecuniary rewards. For such gifts servants are seldom the richer; they often employ them in gratifications which it would be better for them to forego. The *custom* is growing into disuse, and

some very respectable families make it one of the rules in hiring their servants that they shall accept of no such gifts, but when offered shall inform the visiter that it is contrary to the rule of the house to take them.

1497. *Perquisites of cooks* consist chiefly in *dripping*, commonly called "kitchen stuff." This perquisite is very generally allowed, probably from the difficulty of keeping any check upon the cook's use of it if it were not allowed. Every temptation to purloin should be in all houses as much avoided as possible; but in this particular instance it is scarcely possible to avoid it. If the perquisite be forbidden, no one can tell if the cook will not furtively secure it to herself. If it be allowed her, another temptation assails her; that of obtaining as much of it as she can by practices mean and despicable. A cook who grasps at making much of her dripping often over-roasts joints of meat, by which the fat is melted into the dripping pan. She neither protects the fat from the fire by covering it with paper, nor bastes the surface of the meat to keep it moist and rich. She trims from all joints all external fat, to add to her hoards; she uses for frying and for common pastry expensive materials, when she has that at hand which would answer as well, and would more honestly employ the melted fat which is obtained in roasting meat.

1498. *Perquisites of butlers, or of footmen* where butlers are not kept, are chiefly the ends of wax and mould candles; and in the department of the oilman's book many peculations are often practised undetected.

1499. *The dairy maid*, if she has charge of poultry, considers the feathers, when the poultry is killed, as her perquisite. As this may be an inducement to take proper care of the poultry, it may not be a privilege of so injurious a nature as those before noticed.

Subsect. 5.—*Hiring Servants.*

1500. *In hiring servants*, all will desire to have those who have spent most of their years of service, and especially their earliest, in families whose principles, habits, and *general* bearing in their rank of life, are of the best and most respectable description. It would signify little whether such families were of high or inferior standing in society, provided their habits of life enforced on all around them the love and practice of neatness, order, regularity, and cleanliness, and the still more essential qualities of integrity and sobriety. In hiring servants, it is also desirable to have those whose immediate relatives and connexions are respectable, however poor they may be. Those who hold their relatives and friends in respect will not be indifferent to their own characters; they will desire to do credit and not to disgrace an honest parentage, and thus the pride of respectability will be turned to its right use.

1501. *In regulating* the conduct of servants, it is requisite that the legal points in the business should be known. Indeed, the servant, equally with the master, should understand the rights which are mutually possessed, and in what respect the infringement of these rights on either part would affect their contract; in some cases they would find themselves amenable to legal process. Each party should know that servants may be legally punished for insolence, and for assaulting master or mistress; that they may be fined for *drunkenness, gaming, cursing*, and *swearing*; that if by misdemeanour they are legally detained from their master's house, the contract between them is void. On the other hand, if not chargeable with misdemeanour, the master cannot discharge them from his service without paying them that portion of the year's wages which was agreed upon between them on hiring, or allowing them to remain in his service for a stated time after giving them warning, unless the separation takes place by mutual consent.

1502. *On this head the usual agreement between principals and household servants* is to allow on each side a month's notice to be given, or a month's wages to be paid.

1503. *Register Offices*, sometimes resorted to by those who are seeking for servants, have not of late been in much repute, because servants of indifferent characters more frequently apply to them for places than those of a better description. In the metropolis, housekeepers who are constantly engaged in business prefer to avail themselves of the assistance of these offices in suiting themselves with servants, rather than to leave in search of them their lucrative employments. Such persons, not always requiring characters of those whom they take into their service, seldom give any on parting with them, and they reserve to themselves the power of dismissing such servants at a moment's warning; they, on their part, can, if their convenience or inclination induce them, leave their service immediately. Although the common Register Offices are little esteemed, there are institutions of more recent establishment, which at present bear a better character, and are founded on better principles. They have for their object the encouragement of respectable servants, as well as the convenience of housekeepers, and their security from the evils of disreputable and dishonest inmates. Servants whose characters cannot bear the strictest investigation will scarcely apply to such institutions if the promises and regulations of these establishments are observed; for they profess to be so scrupulously minute in their inquiries into characters as to preclude the necessity of those who are hiring from their office taking any concern or trouble in the business themselves. Of these institutions there is one called the Protector, and another the National Benevolent Institution; the former is in Great Russel-street, London, the latter in Bedford Row.

1504. The Protector Institution professes to combine other advantages besides that of supplying families with servants, the only object of a common Register Office. The conductors of the Institution engage, by the precautions they take in applying for characters, to lessen the difficulty of obtaining good and efficient servants. They profess to admit of no recommendation from parties of doubtful estimation, nor to consider slight, careless, and evasive answers to their inquiries as satisfactory. They endeavour to detect the fraudulent practices by which characters are obtained, and by a zealous and rigid investigation to secure their office from the application of those servants whose conduct will not bear the scrutiny.

Subsect. 6.—*Extent of Establishments of Servants.*

1505. *Establishments of servants*, considered according to their extent, may be classed under the following rates:

An Establishment of the First Rate, such as may be supposed to form the household of a nobleman of high rank, number from twenty to twenty-four domestics.

WOMEN.

Housekeeper.
A lady's maid for each grown-up lady of the family.
Cook.
Upper housemaid.
Laundry-maid.
Under housemaid.
Under laundry-maid.
Still-room-maid.
Kitchen-maid.
Scullion.

MEN.

House-steward.
Groom of the chamber.
Valet to each gentleman in the family.
Man cook.
Butler.
Gentleman's footman.
Lady's footman.
Under butler.
Gentleman's coachman.
Lady's coachman.
Couriers—outriders.
Grooms, in number according to the stud.
Under servants — Errand boys — Steward's boy.

To this establishment, that of the nursery (see "Nursery") may be added when requisite.

In an establishment of such magnitude, the duties of its members are perfectly distinct. Order and subordination must necessarily be maintained in it, by the proper administration of the household laws, and by the observance of "household et-

iquette;" or anarchy and confusion, instead of convenience and comfort, would be found within this miniature world.

1506. *An Establishment of the Second Rate, suited to incomes of £5000 or £4500 per annum.*

WOMEN.

Housekeeper.
Lady's maid.
Upper housemaid.
Cook.
Laundry-maid.
Under housemaid.
Under laundry-maid.
Kitchen-maid.
Scullion.

MEN.

Butler.
Valet.
Two footmen.
Under butler.
Two coachmen.
Two grooms.

In this establishment the butler performs the duties of the house-steward as well as those of his own.

1507. *An Establishment of the Third Rate, suited to incomes of £4000 or £3500 per annum.*

WOMEN.

Housekeeper
Lady's maid.
Cook.
Upper housemaid.
Laundry-maid.
Under housemaid.
Kitchen-maid.

In this establishment of women-servants the under housemaid is expected to assist the cook in serving dinner, and the laundress on ironing and mangling days.

MEN.

Butler.
Footman.
Under butler.
Coachman.
Groom.

The butler here performs the duties of the valet, as well as those of the house-steward.

1508. *An Establishment of the Fourth Rate, for incomes from £2000 to £1500 per annum.*

WOMEN

Housekeeper.
Cook.
Housemaid.
Laundry-maid.

In this establishment the housekeeper is expected to superintend the cooking, and to act, if required, as lady's maid also.

MEN.

Butler.
Footman.
Coachman.
Groom.

1509. *An Establishment of the Fifth Rate, for an income of £1000 or £1200 per annum.*

Cook.
Housemaid.
Under housemaid. Expected to assist the cook when serving her dinner.
One man servant.

1510. *An Establishment of the Sixth Rate. Income from £700 to £600 per annum.*

Cook.
Housemaid.
Footboy.

1511. *An Establishment of the Seventh Rate. Income £500 to £450 per annum.*

Cook.
Housemaid.

1512. *An Establishment of the Eighth Rate. Income £300 to £250 per annum.*

1 maid servant.
1 girl.

1513. *An Establishment of the Ninth Rate. Income £200 to £150.*

A maid of all work.

Incomes still less will admit of a girl only, or with the occasional use of a char-woman.

SECT. V.—DUTIES OF MEN SERVANTS.

SUBSECT. 1.—*Duties of the House-steward.*

1514. The house-steward is the representative of his employer in all matters of business connected with the house: he hires, discharges, manages, and directs every subordinate member of the establishment of men servants, with the exception of the valet, whose conduct and qualifications come more immediately under his master's notice, and more materially affect his comfort than those of any other member of the household.

1515. *The steward purchases* every article consumed in the house; and it is necessary for him to have very sufficient knowledge of the qualities of the articles to be bought, and the right season for laying them up. He should never deal with any but tradesmen of known probity, whose interest it is to recommend to him only the best of their commodities.

1516. *In accounts the steward* must be ready, though domestic bookkeeping, not being of a very complicated description, requires great accuracy rather than proficiency in the science of figures. It consists chiefly in keeping a strict account of moneys received and disbursed. The mode in which his accounts are to be kept is sometimes directed by his employer. If left to his own arrangement, his desire should be to render them simple, or he may give his principal unnecessary trouble at the periods of their examination. Neither should he trust to memory, but make instant memoranda of all payments and receipts; nor, if he regard his own interest, will he pay any sum away without demanding in return a proper receipt. By not doing that, he may subject his master to the liability of a second payment, and himself to the loss of his situation and character. All current accounts are usually made up by the steward half yearly; and when examined by his employer and found to be correct, a receipt or acknowledgment of their accuracy is given him by his master.

1517. *In the room appropriated* to his use the steward keeps his books and files of bills. In the room also he makes a point of remaining for certain periods each day, that all the other members of the household may find him ready to hear their questions or complaints. This done, he then proceeds to the different offices to see that in each the duties of the day are properly engaged in.

The house-steward, in some instances, has the general superintendence of the stables, seeing into the fair and honest use of hay and corn; but this duty is usually performed by the coachman.

Whatever superintendence or investigation is usually given, in smaller establishments, by the principal himself, the house-steward must consider himself as bound to do. These duties all inquired into, the steward then examines into the state of the larder and stores, and prepares for market. The purchases are given into the housekeeper's hand, who, after weighing and examining them, gives him in exchange vouchers, which are afterward compared with the tradesmen's accounts.

SUBSECT. 2.—*Duties of the Valet.*

1518. *The valet*, in small families, is expected to assist as footman also; but his particular province is to attend exclusively to the personal accommodation of his master.

Upon him he waits during all times of dressing and undressing; brushes, folds up his clothes, or places them in readiness for him. All repairs he sees done; and on putting away cloth clothes into a wardrobe, he uses the precaution of covering them with brown holland or linen wrappers, to secure them from dust.

Boots and shoes (cleaned by the under-footman) should be placed every morning ready in the dressing-room. The valet should see that the housemaid cleans the grate, lights the fire, and sweeps and dusts the room, while he prepares the washing-table by filling the ewer with soft water, and the carafe with fresh spring water, and by putting in their right places basins, towels, and brushes: hot water and the shaving apparatus should be at hand; the linen and slippers airing at the fire; and the rest of the apparel to be worn hung across the backs of chairs, and covered over with holland wrappers.

1519. *After the dressing is over,* the valet should take the earliest opportunity of cleaning and putting away the razors, and everything which has been used, in its proper place. See "Cutlery," Chap. XVIII., Book V.

1520. *For wet weather,* when his master may come in from riding, the valet should be always prepared, by having ready the necessary changes of linen and clothing, and by being himself in waiting, to remove the damp clothing, and to prevent its being injured in the drying.

1521. *Before putting damp woollen clothing to the fire,* it should be rubbed with a sponge, the way of the nap, until the smoothness of the surface is restored. If dried without this precaution, brushing will not be effectual in removing the roughness.

1522. *In preparing for journeys,* the valet should endeavour to ascertain the probable time of his master's absence, that he may be able to provide a sufficiency of linen and other clothing. At the inns he takes charge of these supplies, and, as at home, places everything in readiness for the periods of dressing and undressing. Besides this, if his master be unattended by his footman, it is his duty to attend to his accommodation generally, as well as in his dressing-room. Whenever his master needs his services, he must be at hand; even at table, if more than ordinary attendance be required, he must be ready to wait.

SUBSECT. 3.—*Duties of the Butler.*

The butler ranks as second in a complete establishment.

1523. *The butler is chiefly responsible for the management of the wine and ale cellars,* and for the direction of the various repasts of the family.

1524. He is also responsible for the plate, giving it out in due quantities to the under butler to clean. *His morning duties* are, *first,* at the breakfast table; *secondly,* in the wine and ale cellars, in which it is probable he may have to rack, fine, and bottle. *Thirdly,* he sees that the footman, under butler, and steward's boy are each engaged in his proper department. The immediate superintendence of these servants falls on the butler, who is responsible for the propriety, neatness, and cleanliness of everything at table, and which can only be effected by each department of duty being properly fulfilled. *Fourthly,* he dresses and stations himself so as to be at hand to open drawing-room and parlour doors to all visiters or members of the family passing to and fro. *At luncheon* he waits, unattended by a footman, unless, company being present, the size of the party requires more aid. *At dinner and tea* he also attends; and between these two repasts he answers bells and waits upon the company, while the footmen are engaged in clearing away, and cleansing whatever articles in their department have been used at dinner. *At bedtime the butler* brings up night candles; and, when the family and company are retired to their rooms, he locks up the plate, sees that windows and doors are secured, and fires left in no dangerous state.

In addition to these daily cares are those of the wine and ale cellar; the wine required each day he brings from the cellar himself a short time before dinner; decants it, and keeps it under lock and key till wanted. The servants' allowances of ale he draws himself; and at some seasons he has to fine, bottle, cork, seal, and place in the bins wine purchased in the wood. He has to make regular entries in his cellar stock-book of the number of bottles used, of the age and character of wines in each bin. The brewing, racking, and bottling of ale and other malt liquors, belong also to his department of duty.

1525. *The butler, in establishments of second and third rate,* undertakes some of the duties of the house-steward and valet, having, like the former, to market, pay bills, and to superintend all the other departments of the men servants as to the daily performance of the duties of each; and, like the latter, to give also personal attendance, at stated seasons, in his master's dressing-room.

SUBSECT. 4.—*Duties of the Man Cook.*

1526. The man cook is, in this country, found chiefly in the large establishments of princes and noblemen, or in those of very affluent families. He is also occasionally the superintendent of the kitchens belonging to public institutions, hotels, clubs, &c.

He makes out bills of fare, which are sometimes submitted to the principals for approbation. For this part of his duty it is requisite that he should be well acquainted with the high season of every dish (almost every dish having its season), and be able to perceive the exact state of everything he has to prepare. If he cannot make a good selection of the articles which are to be submitted to his skill, he will in vain exert that skill, and his employers will be disappointed in the result. No art can give excellence to an inferior article, or restore qualities which have been destroyed by natural changes in the substances themselves. *The man cook,* besides superintending the cooking generally, chiefly prepares the rich stews, ragouts, soups, and other dishes of a complicated description, not understood by ordinary cooks, whose greater variety of business precludes their attainment of the highest degree of proficiency in the art. Excellence in cooking can only be the result of practice and experience; united to which, it must be acknowledged that reflection and judgment are indispensable qualities in the character of a cook. As in chemical experiments one successful result leads a reflective man to attempt others, so, in cooking, one approved recipe may be productive of many varieties. In no dinner party would there be uniformity of taste; and the skill of the cook must therefore be exercised in meeting this with such various flavours as may give to every guest an equal chance of gratification.

SUBSECT. 5.—*Duties of the Footman.*

1527. *The footman's routine of business is, in a complete establishment,* of a subordinate description.

In the morning he assists in rubbing mahogany furniture in the dining-rooms and libraries; cleans windows; and sets ready for use, in the butler's pantry, all the articles which may be required for the breakfast tables, and which, after breakfast, he has again to clean and put by into their proper places. Afterward he cleans himself, and prepares to attend the carriage, to answer bells, or to obey any orders given him by his master or mistress. If he has to follow the lady whom he serves, or any of the female part of the family, in their walks, he is not to consider himself as a mere appendage which marks the condition of the family he serves, but as a protector from the inconveniences and annoyances which may occur to ladies walking in a thronged and busy place. For this end he should follow his mistress at such a distance as to be immediately at hand if his aid or interposition be necessary, and yet not so near as to hear conversation which may be passing between her and her companions. *At dinner* he again attends, having previously assisted to prepare the table for it. Dinner ended, his next duty is to clean and put away the same things, while the butler attends to the bells of the dining and drawing-rooms. *At tea* he again waits; and, generally speaking, his daily avocations end after the tea things are brought from the drawing-room, washed, and put away, the butler usually seeing to every subsequent duty.

1528. *The footman in small establishments of servants,* or in families in which only one man servant is kept, has more general and constant occupation than those who belong to "the complete establishment."

In the former case, not being under the control or dictation of a superior servant, the general arrangement and management of his employments devolve on himself; and, unless he has method, he will feel hurried and overdone, without being able to give his employers satisfaction. In describing the daily routine by which his occupations may be pursued with precision and method, it must be remembered that in each family there may be circumstances and customs to which the servants must conform, and adapt their business accordingly.

1529. *The mode in which a footman plans his work* on entering a new service, with the determination he shows to adapt that plan to the circumstances around him, and, when once settled, to adhere to it with as little deviation as possible, displays ability and a most desirable habit of order.

1530. *The sole footman* in a family has to perform some of the duties both of the superior and inferior members of the complete establishment; and if in a numerous family, or one which has frequent company, it will require all his diligence and activity to keep everything straight and in good order.

He must rise early, and endeavour to get some of the roughest part of his work done before his breakfast, and before he is required to appear in the breakfast-room. In order to preserve the cleanliness of his clothes, he should be provided with a complete overall suit, made of materials that will easily brush clean or bear washing. Covered over with these, he brushes the clothes of the gentlemen of the family, then cleans and polishes their boots and shoes, which the night before, if wet or damp, he had placed at a proper distance from the fire, to dry them gradually: an attention which enables him afterward to give them a finer polish. These done and set ready to convey to their owners, he then cleans the knives and forks, wipes them, and puts them away till wanted. After this he washes and cleans himself previously to the preparations for the family breakfast table. *After laying the cloth, and placing the required number of cups, saucers, plates,* &c., he puts the heater into the kitchen fire, sees that water is boiling, and the supplies of bread, butter, &c., ready, and then is prepared for the summons for the urn. His own breakfast time is regulated by that of the family, the footman in some houses taking breakfast with the other servants, and in others in his own pantry on the remains of the family breakfast.

After the footman has himself breakfasted, washed, and replaced in the china closet whatever has been used of china at the breakfast table, together with the plate, waiters, and trays, he must direct his attention to the cleaning of candlesticks (see "Cleaning"), trimming of lamps (see "Artificial Illumination"), putting them in right places in his pantry till they are wanted. The mahogany furniture in the dining-room or library he must rub daily; and twice weekly he ought to wash away any spots it may have acquired, restoring afterward the polish it may have lost, by any of the means mentioned under "Cleaning." Some of the windows he should clean weekly, availing himself of periods in the day when the occupants of the rooms are absent from them. Afterward returning to the pantry, he should set himself to prepare something or other for the dinner table; either to rub the plate, to wipe the glass, &c., until it be time to prepare for the luncheon. During this part of the day he should be in such a dress as is not inconsistent with his employments, nor yet unfit for him to appear in if summoned by bells to the parlour or to the hall door. A coloured cotton or plain cloth jacket and white linen apron are usually worn by footmen while engaged as above described. *The parlour luncheon* being generally called for about one o'clock, he must have the tray set ready; when carried into the parlour, and properly arranged, he will usually be at liberty to get his own dinner, which is generally ready at this period of the day. When his mistress requires it, the footman should be ready to attend her, either with the carriage, or to follow her if she walks out. For this latter part of his morning's duty he should be neatly dressed; his clothes and hat should be well brushed; his shoes and stockings and gloves clean. A dirty-looking footman is a disgrace rather than a credit to a family. In giving directions to the coachman he should be quick and accurate; nor is it altogether needless to remark that, even in his announcing rap at the doors of the parties on whom his lady calls, there is a propriety to be observed as to its measure and degree; if too loud and long, it disturbs a whole neighbourhood; if too insignificant, it may be deficient in respect to his lady. In following her during her walks, he should preserve a steady decorum of manner, and be observant and ready in case any emergency should make his aid necessary to her.

1531. *Waiting at table* is one of the most important parts of his employments, and requires more skill and attention from him, if unaided by others, than when he is one among many attendants. Here, any neglect of his other duties will be apparent, and the censure must fall on him alone. Knives, forks, plate, and glass will all tell of his industry or of his negligence.

The general deportment of a footman, while waiting at dinner, should be quiet and quick, but not hurried or bustling: he should tread lightly, change plates, knives, &c., without clatter, and should speak as little as possible, and never in a raised tone of voice, unless it be necessary in answering questions. He should hand everything with the left hand, and to the left of the person he is assisting to anything. The tablecloth, in removing, should have each side and ends lightly thrown together, and be carried out of the room, and laid aside until a convenient opportunity for shaking it and folding it up. On formal occasions the tablecloth is left, and long slips down each side are used, and removed when dinner is over. It should be wrapped up in the folds

previously made, and placed carefully in the table-linen press. *Dinner over, and the dessert and wine properly placed on the table*, the footman retires to his own pantry to wash glasses, &c., and to put everything once more in its right place. Then he prepares for taking up coffee and tea; puts the urn heater into the fire, places teacups, &c., on the board; and sets cakes, bread and butter, milk, &c., on his waiter, ready to carry to the drawing-room when required. At night he closes all window-shutters and locks up doors; carries up bed candles; takes the slippers to his master; and, lastly, collects, as far as he can, all small articles of plate, such as teaspoons, which are in constant dispersion during the day in most houses; counts all over; locks it up or places it in security—and thus closes his daily business.

1532. To place candles properly in the candlesticks, though not strictly a branch of cleaning generally, completes this part of the footman's work. Candles should be placed perfectly straight in the candlestick; any inclination from the perpendicular being not only disagreeable to the eye, but causing the tallow or wax to run wastefully down the sides, because the heat of the flame acts more powerfully on one side of the candle than on the other. The same effect is produced by dirt or soil on the surface of the candle, as also causing an irregular action of the heat. If the nozzle of the candlestick be too large for the candle, a small fold of paper must be put round the candle, not so wide as to be visible when the candle is placed in it. The wick of the candles, if they have not been previously lighted, should be just set fire to, and blown out. For this, when they are wanted, they will light the more easily.

1533. *In trimming candles* which have been previously in use, it is desirable to pare off the top, so as to form again the conical shape into which they had been originally moulded. The object of this is to prevent that surplus of melted tallow, caused by the heating of so large a circumference of tallow, and which the wick cannot at first consume, from flowing down the sides of candles, wasting as well as disfiguring them.

1534. *Candle ends*, mould as well as wax, ought to be used upon save-alls by the servants, and not put into the box of scrapings, to add to the perquisites of those whose office it is to clean the candlesticks.

SUBSECT. 6.—*Duties of the Under Butler.*

1535. *The under butler* is under the immediate control and direction of the head butler. The charge of the plate in daily use falls on him, he being responsible to the butler for the quantity given out to him, and for keeping it in proper order for the table. (See "Cleaning.") He also cleans the knives and forks used in the family, assists in laying the cloth, arranging the sideboards, and in waiting at table. With these occupations, he is not expected to answer summonses of the bell, unless particular circumstances render that necessary, when, this being specified to him by the butler or steward, he must arrange his other work accordingly. He must always be ready, when occasions press, to lend his assistance in any of the duties usually performed by the butler or footman.

1536. *In all business of the cellar*, such as brewing, bottling, fining, &c., he assists, and is expected to be almost as expert as the butler.

SUBSECT. 7.—*Duties of the Inferior Household.*

1537. *The duties of all inferior household* servants, men or foot-boys, consists in their sharing the inferior parts of the work with upper men servants, such as cleaning knives, and shoes, and windows, going of errands, and sometimes attending the carriage, to open the door of which, and to give orders to the coachman.

SECT. VI.—DUTIES OF WOMEN SERVANTS.

SUBSECT. 1—*Duties of the Housekeeper.*

1538. *The housekeeper of a first-rate establishment* has, like the steward in his department, *the entire direction of the female servants*. Her value and importance to her principals depends mainly upon her vigilant superintendence of each branch of female service, and on her constant investigation into the efficiency, steadiness, and general good conduct of each individual under her charge. It is her duty to see that the business of the house is regularly and properly performed; that everything is done in its right season, everything applied to its right use, and kept in its right place. Order, with despatch, should be the law of the house: a law that carries on every business easily and tranquilly. Where observed, confusion and hurry rarely occur.

The care of the furniture, of household linen, of all culinary and domestic utensils, devolves on the housekeeper. The charge of the store-room belongs to her also. Whatever stores are purchased she receives, examines, and weighs them; notes down, either in the store-book, or on tickets which she gives to the steward, the weight of each article, such memorandums serving as a check upon the accounts of tradespeople. She stores the deposites in appropriate jars or vessels, and places each commodity in a situation best suited to its nature as to temperature.

1539. *With cooking generally the housekeeper has little concern.* Her care of the table is confined chiefly to pickling and preserving, and in preparing confectionary, arranging the dessert, and making the ice-creams. These preparations are all performed in the still-room, and with the assistance of the still-room maid. Fulfilling each branch of her duty faithfully, the housekeeper, at the head of a large female establishment, has no sinecure.

The early hours of the day are engaged in seeing that others are properly at work, then following her still-room employments, &c.; when all household business is ended, she has to set the maids to their sewing, placing in their hands the household linen which requires to be made or to be repaired.

Her evening should be occupied with preparations for the ensuing day. Lump-sugar is broken, raisins stoned, currants washed, cleansed, and dried. Spices pounded and bottled, oranges and lemons peeled, and the juice strained and bottled for use.

1540. *In her books she has then to enter expenditures of the day*, and to note down such articles as are required in her store-room. Half yearly, or at convenient periods, she has to compare the inventories given to her on entering the family, with the articles enumerated, and in making out new lists she makes notes of the deficiency which time or other causes have produced, and also of the articles which have been added to replenish such deficiencies.

1541. *The housekeeper* at the head of a smaller establishment, in which there is neither house-steward nor man cook, has many other duties to perform besides those enumerated above; marketing in such a case falls on her, and the higher branches of cookery, together with the arrangement of the table.

SUBSECT. 2.—*Duties of the Lady's Maid.*

1542. The duties of the lady's maid, if not arduous, are unremitting, between her attendance on the *toilet* and her charge of the *wardrobe* of her lady. Her daily occupations commence with arranging the dressing-table, after the housemaid has swept and dusted the dressing-room, lighted the fire (in cold seasons of the year), and brought up hot water.

1543. *After setting out and preparing* everything which may be required, she awakens her lady at the proper hour, and then retires till summoned by the bell to attend her, to brush, comb, and dress her hair, and assist in the completion of her morning's toilet.

After replacing or putting away everything which had been used, she next directs her attention to the state of the wardrobe; occupying herself in making new, or in repairing any old articles of apparel, until her lady again requires her attendance, either in preparing herself for riding, walking, or in dressing for dinner. At night, also, she arranges everything for the retiring, as she had in the morning done for the rising, of her lady. A lady's maid needs possess, it is evident, very different qualifications and attainments from those of any other member of the establishment. *Her taste* in dress should be cultivated, or she will be unable to judge in the dressing-room of the effect which the *tout ensemble* of her lady's costume will have in the drawing-room. She should require a knowledge of the most agreeable combinations of colours, and of the effect these produce on different complexions. If she have also a ready perception of the proper *set* (to use a technical expression) of each part of a lady's attire, and have the art of giving this effect or *air* to the dress of her employer, she may be regarded as a skilful tire-woman. It is this art which gives more style and elegance to dress than the costliness of the materials; it is the finishing stroke, without which the *chefs-d'œuvre* of the dress-maker and milliner would be incomplete; for the proper set in dress is usually more apparent in a French woman than in that of an English woman, and thence the more frequent admiration of the dress of the one than of the other.

1544. *The use and mode of applying rouge and cosmetics* should also be understood by the lady's maid.

1545. *In applying cosmetics*, it is requisite that every lady's maid, as well as every lady, should know how far they are innocent or injurious. Ignorance of the nature of these external applications may be fatal both to the complexion they are intended to improve and to the health, the state of which has more effect upon the skin than any cosmetic whatever. It is probable that there are many situations as lady's maid in which the use of cosmetics and rouge is unknown; but whenever they are employed, the knowledge here recommended should be acquired. (See "Business of the Toilet," Book XIX.)

1546. In *hair-dressing*, the lady's maid should be skilful and ready in perceiving every variation of style which fashion may cause; these she should be able to adapt and render becoming to the countenance of her lady.

1547. *The charge of the wardrobe requires that in dress-making and millinery* she should be a proficient; although her skill in these arts cannot be supposed to be equal to that of the professed milliner and dress-maker, because her opportunities of studying fashion cannot bear any proportion to theirs. As a seamstress, expertness both in making and repairing linen will be expected from her; and she should consider that the contents of the wardrobe being under her care, she ought to be capable of using her needle in whatever way the different articles in it may require. Clear-starching, getting up laces and nets, washing gauzes, crapes, and silk stockings, removing stains of fruit, or soils from silks, preserving furs, woollens, and other winter clothing from moths, all belong to the duties of the lady's maid. (See Book XXII., "Laundry.") Nor must she neglect to note the quantity of linen sent to and returned from the laundry, nor to make occasional comparisons of the contents of the wardrobe, with the inventory given to her on her entering the service of her lady.

Should she be the attendant of an elderly or infirm lady, it may be requisite for her to be able to read aloud agreeably, and to write neatly: acquirements which may be easily gained with diligence and attention.

SUBSECT. 3.—*Upper and Under Nurse Maids.*

1548. *An upper nurse*, where there is an infant, takes entire charge of it, washes, dresses, feeds it, carries it out of doors, and when in the house only gives it to others to nurse when her other duties call her away from it: the other children in the nursery are all under her superintendence, as well as the subordinate assistants. These last, it is requisite, should be under her direction and control.

An upper nurse is always expected to live entirely with the children intrusted to her; that is, to have her meals in the same room with them after they have finished. Once or twice a week, if the children are well, and all asleep, she is usually permitted to sup in the housekeeper's room, as affording her a little change and variety; but unless all is going on well with her young charges, this indulgence she must forego. A post of such responsibility as hers, and for which she is usually liberally remunerated, must not be lightly abandoned to a junior servant; therefore, if her charges are feverish, restless, or otherwise indisposed, she ought never to leave them for any length of time, but to be at hand, and ready, should they need her attention and assistance. The children's clothing, also, is under her care. She should see to the repairs they may require being done, and that they are kept well aired, and ready for immediate use.

1549. *The duties of the under nurse* maid consist, if no girl under her is kept, in doing the work of the nurseries, lighting the fires, sweeping, scouring, dusting, making beds, emptying water, and replenishing the water ewers, bringing up and carrying down the nursery meals. Also in washing and dressing all the children in the nursery, except the infant; putting them to bed, and assisting them to arise in the morning. In the evening she must also assist to mend and make the children's clothes, and at all other times when there is nothing else to be done for them.

1550. *Sometimes a nursery girl* is added to the nursery establishment, whose duty consists in assisting the others generally, but particularly in the rougher parts of nursery work, such as in scouring, bed-making, washing children's clothes, cleaning grates, &c. She also is expected to carry up to the nursery coal, water, and everything required at the meals of the children. Her own meals are taken in the nursery, as well as those of her superior fellow-servants.

1551. *A nurse maid* in families of small income has generally the whole work and management of a nursery, assisted principally by the superintendence of her mistress; and in regard to the harder parts of her duty by the housemaid, in such a situation the housemaid is usually engaged to carry up and down whatever is required at the nursery meals, and to walk out once a day with the children.

SUBSECT. 4.—*Duties of Cook, Kitchen-maid, and Scullion.*

1552. *The routine duties of cook, kitchen-maid, and scullion being intermingled*, can scarcely admit of separate descriptions. The cook directs the whole business of the kitchen; the others assist in its performance; she is responsible for the mode in which it is conducted and performed, and must possess, therefore, adequate skill; they, on their part, have only to be active, cleanly, and obedient.

1553. *To these domestics, early rising* is of the utmost importance, and, as their hours of retiring to rest are less uncertain, and not dependant, as those of the servants in other departments, on the movements of the family, there can be neither hardship nor difficulty in their rising betimes, not later than 6 in the summer and 7 in the winter. If they fail in this, they will find that "an hour lost in the morning may be run after, but never overtaken the rest of the day." The inconvenience of late rising in these three domestics will not only affect their own, but the business also of many of the other servants.

1554. *The first care of the cook*, in rising, is to set her dough, if not done over night, for the breakfast rolls and cakes; *while the scullion* cleans grates and fire-irons, lights the kitchen and oven fires, and fills with water, boiler, kettles, and fountains, sufficient for the supply of the dressing-rooms, as well as for breakfast.

1555. *The kitchen-maid, at the same time*, is occupied in sweeping and cleaning the kitchen, larder, and other offices belonging to the kitchen; together with the halls, stone steps at the house entrance, office passages, kitchen stairs, &c. Besides this daily sweeping and dusting, she has to scour and wash all these places twice a week, and to scrub tables, shelves, and cupboards.

1556. *The scullion*, in the same manner, keeps her scullery clean, and all the metallic utensils used in the kitchen, as well as earthen plates, dishes, and other vessels.

1557. *These preliminary employments* usually occupy the three domestics till their breakfast hour, 8 o'clock. That meal over, their attention must be immediately directed to preparations for the different dinners of the household and family.

1558. *The kitchen-maid* generally dresses *nursery and servant's hall dinners;* at the same time, she has to clean and scrape fish, pluck, draw, and truss poultry, trim joints of meat and cutlets, wash and trim vegetables, laying them on separate colanders to drain (for, if heaped on one another when moist, the strong vegetables impart their flavour to the more delicate plants); all such offices she undertakes.

1559. *The cook* has only the charge of dressing and serving the principal meats. While everything is thus prepared for her, she is busy with her pastry (best made early in a summer's day), her ragouts, soups, gravies, farces, &c.; the stock or *consommé*, the basis of most made dishes, she keeps always at hand, as well as sweet herbs, pounded spices, eschalots, cloves of garlic, &c. From this time till the dinner is served the cook must never leave her post, nor allow her assistants to remit their occupations.

1560. *As the time draws nigh when the whole business must be achieved*, the clock must be consulted, and to each dish due time allowed for the fire to complete what has been thus prepared. Now the cook must be collected as well as busy, that there may be no oversight of any kind (see art. "Cooking"). The vegetables and sauces must, in their preparation, keep pace with the dishes which they are to accompany, so that the order of the dinner may be carefully observed.

1561. *The dinner hour* arrived, the cook commences serving such things as may, without injury, be covered over, and placed for a short time on the hot hearth, or in the hot closet (see "Kitchen Apparatus"). But choice or important dishes she refrains from serving until the order for dinner has been given from the drawing-room. Then all hands are at work. The cook takes immediate charge of fish, soup, and poultry. The kitchen-maid (in some houses assisted by the under housemaid) dishes vegetables, and pours gravies and sauces into tureens. The scullion waits the bidding of the cook. All are thus busy, and yet without confusion.

1562. The serving table (in some kitchens heated with steam) is covered with a clean cloth, and the first course is set upon it, and carried thence by the footmen, in regular order, to the butler in the dining-room. The cook's constant aim should be to serve her dinner neatly, and, above everything, to send it up hot. If cold, her painstaking in all other respects will avail little. *Also, of the second course* she should time judiciously the dishing; if deferred too long, an awkward lapse in the dining-room will occur; if too soon, some of the light and fancy dishes, such as omelettes and fondus, may be injured.

1563. *The serving ended*, the cook then sets her assistants again to the business of cleaning: the utensils are scoured; the scullery, larder, &c., cleared of everything that might betray negligence, or affect the atmosphere with unwholesome odours. The cook employs herself in the larder, putting away, on clean dishes, any remains of the dinner, and which are to be disposed of according to the custom of the family in regard to their table. In some families it is usual to send to table the following day some of these remains properly made up; in other places they are consumed at the second table; and in a very few houses, of the highest rank and equal affluence, these remnants are disposed of to the poor in the vicinity, to whom allowances are made according to the numbers of their respective families. Whichever of these customs is established in the family, the cook must, of course, conform to it.

1564. *The contents of the larder*, which is under the charge of the cook, require her daily attention; and, during warm and damp weather, she should investigate their state in the evening as well as in the morning. Undressed butchers' meat, poultry, and game, if moist on the surface, should be wiped dry; if fly-blown, the part should be cut away; and if still greater change be perceptible, if a flaccid state of the flesh, as well as moisture on the surface is perceived, it may be prudent to resort to more decisive measures to preserve the food from becoming utterly unfit for the table; and a single night may do this if precautionary measures are neglected. (See "Preservation of Food.")

1565. *The cook, even if she have a kitchen-maid* under her, must never neglect to see that the larder is kept clean, and that no unwholesome smells arise from droppings of meat, or gravies, milk, &c. The leaves of vegetables left to ferment must also produce exhalations detrimental, especially in hot weather, to all moist food.

Soups, gravies, and *milk* should each be put daily into clean vessels: unless this be done, they will soon begin to change. If soup or gravies are not immediately wanted for use, they should be boiled up, and then strained into cold vessels, and put into the coolest place to be found till they are wanted. All vegetable substances should be strained from them.

1566. *In second-rate establishments* the housekeeper usually superintends the higher branches of cooking, and the cook undertakes the minor duties of the kitchen-maid, either with or without the assistance of a scullion.

1567. *The cook engages in small establishments*, varying from three to five in number, to perform the whole of the work in the kitchen, and in some places portions of house work; she has also to clean the hall, passages, stone entrance, steps, and kitchen stairs, and occasionally the dining-room, or the whole of the ground floor. It is apparent that, with this variety of occupation, she must require *method* as well as activity, or she will be hampered and hurried, and perhaps perform no part of her duty well. *Method* must be her law; and it consists in a judicious division of her weekly, as well as of her daily work, and to her regular adherence to this division, performing in its appointed time each portion of her duty. It may be useful to give a detailed account both of the day's and week's routine of her business, to show how even this variety of household work may be easily and well performed.

1568. First. *The routine of the day's work. Early in the morning*, the kitchen grate or stove, oven, and boiler must be cleaned, the fire lighted, and the water set on for breakfast. The hall must be swept out, stone steps washed, dining-room grate and fire-irons cleaned and polished, carpets swept, chairs and tables rubbed, and windows dusted, curtains shaken and properly arranged, and the fire, if in the winter, either kindled or laid ready to be lighted. *After breakfast*, in places where it is required, the cook assists the housemaid with the beds, one pair of hands being insufficient to shake large beds and turn mattresses properly. After this is done she returns to her province in the kitchen, answering door-bells and single knocks until twelve in the day, in order that footmen and housemaid may pursue undisturbedly their respective business. At noon, however, the cook's business will require her constant attention, especially if she have two dinners to prepare. The early dinner she has probably forwarded before twelve, and been, at the same time, able to put her kitchen in order, and to clean and clear away any utensils that may have been used since the morning. During the hours of cooking she should be solicitous to keep her kitchen in order, removing out of it as quickly as possible all plates, dishes, and other articles that have been used into the scullery, to be washed in proper season. Nothing betrays want of method more than the neglected state of any servant's office; it brings confusion into the whole business of the kitchen. As, in families where there are small establishments of servants, the table is generally plainly served, the cook may find many intervals of time for washing up her earthen-ware vessels, and putting away all articles which are not likely to be wanted; and by constantly doing this, she will be less hurried at other periods of her business. After serving her dinner, her kettles, saucepans, and stewpans must be properly washed and cleaned, and ranged near the fire to dry. By the time these are done the plates and dishes will be returned to her from the dining-room, and must be immediately washed, and either ranged in the rack or put to dry before the fire. Then she makes up her kitchen fire, cleans and sweeps kitchen, larder, and scullery. In families where the dinner is late, supper is rarely wanted, so that the cook's employments are ended when all the operations above mentioned are performed. She may then clean herself and sit down to her own work, or to repair and make kitchen towels and cloths, until the hour for rest.

1569. Secondly. *The routine of the week's work. Monday*, in country families, is a baking day. The bread is often set over night, but is not kneaded and formed into loaves till the next morning, after the cook returns from assisting the housemaid with the beds. The cook has often more to do on this morning in washing up everything which her attendance at a place of worship, the previous day, had rendered it expedient for her to leave untouched. This, with her daily business, usually occupies all her spare time. *Tuesday*, her kitchen, larder, scullery, &c., to be scoured; tables and dressers washed. *Wednesday*, the dining-rooms and library more thoroughly cleaned than on ordinary mornings. These must be done as soon after the family breakfast as possible. *Thursday*, passages and oilcloth washed, together with the stairs and banisters apportioned to the cook. *Friday*, all tin saucepans, metal dish covers, copper saucepans, &c., to be scoured and polished; baking. *Saturday*, the kitchen, larder, &c., scoured; the oilcloth in hall swept clean and polished. In a place where the cook engages to wash her own clothes and kitchen towels, she must, at the stated periods, arise an hour or two earlier in the morning, and by getting on with some portion of her work, she will make time for this extra business. The ironing and getting up of her linen may generally be done in the evening.

SUBSECT. 5.—*Duties of Upper and Under Housemaids.*

1570. *The upper housemaid's duties* vary according as she has one or more assistant housemaids, upon whom the most laborious parts of the household cleaning devolve, in distinct proportions to each, and yet the upper housemaid is, in some measure, responsible for the whole of the household work being well done and in proper season. Hence it is requisite that she should herself be well versed in every detail of the work, and be able also to estimate the rate of time at which it ought to proceed, so as it may be always effected regularly, easily, and properly.

1571. *Daily work of the upper housemaid.* Her daily occupations commence, together with those of her assistants, in the rooms of which the use will be first required. The windows of these are to be opened in the first instance, weather permitting it; the curtains are then to be shaken, and hung up high enough above the carpet to remove them from the dust which, in sweeping, will rise from it. The sofas, couches, and choice furniture must be covered, if this have not been done over night, with loose sheets of coarse calico or brown holland, and the rest of the room is to be prepared for the sweeping of the carpet, by the removal of chairs, sofatees, small tables, &c., away from the sides and towards the centre of the room; damp tea-leaves being sprinkled over the carpet, will assist in catching the dust as it rises in sweeping, and thus prevent it from settling on the furniture or walls of the room. The sweeping, then, should be begun from the upper end of the room, and proceeded with towards the fireplace, or the lower end of the room, according as the pile of the carpet appears to be. The sweeping must not go against, but with the pile. When the sweeping is done, the upper housemaid proceeds to remove the chimney ornaments, as well as others from chiffonières and tables, in order to dust the places on which they usually stand. Marble chimney-pieces or slabs should be washed occasionally by the upper housemaid with a flannel, and clean soap and water. (See art. "Cleaning Marble.") The various ornamental articles that have been removed will require careful wiping or cleaning, and are then to be replaced The ledges, panels of doors, window-frames, the inside of the lower panes of the windows, the mirrors, chairs, sofatees, &c., and tables, are then to be dusted and put into their respective places; the frames of pictures must be dusted, but only with a feather broom, not with a linen duster. (See remarks in art. "Cleaning Gilt Mouldings," &c.) At last the curtains are to be neatly laid in folds and hung on their brackets; but, even

when everything appears to be done, the housemaid should pause before she leaves the room to take a general survey of the whole, in order to detect omissions which may have occurred in any details of the business. When she has done her part in each room, and seen also that others have done theirs, her next business is with the dressing-rooms, into which warm water may be taken, and all things of the toilet laid ready for the lady she is serving, or other members of the family. When these matters are all settled, the hour of breakfast will probably be arrived, which, in regard to the establishment, generally precedes by one hour that of the family.

It may be as well here to notice the circumstance that, in families in which men servants are kept, the care of the dining-room mahogany furniture, together with the cleaning of mirrors and windows, are always under the charge of the men servants. (See art. "Cleaning Furniture.") Rosewood tables and chairs, or other French polished furniture now usual in drawing-rooms, requiring no cleaning, and nothing more than gentle rubbing with silken or soft linen dusters, are usually under the care and management of housemaids.

1572. *An under housemaid*, while an upper has been employed as above described, ought to be performing *her* distinct part of the business, that of cleaning the grates, fenders, and fire-irons.

After removing the hearth-rugs, she should lay down on marble hearths, to preserve them from being scratched, a coarse wrapper cloth about two yards long and one yard and a half wide, and which should always be one of the appendages of the box which contains her other implements and materials for cleaning grates, &c., as well as a pair of thick buck leather gloves, which may be purchased at oil shops for housemaids' use at one shilling per pair. These gloves are very useful, not only in protecting the hands of the cleaner of the grates from becoming hard, discoloured, and unfit for nicer work, but in securing also fine steel work and fire-irons from the touch of the hands, which, if moist, would injure them. Having cleared the ashes away from the grates, and cleaned the bars, fenders, and irons in the rooms used for eating or sitting in, she then carries her box of materials into the dressing-rooms or bedrooms in which fires are to be lighted.

1573. These rooms done, the housemaids repair to their breakfast, and afterward to such of the bedrooms as have been vacated. Here the windows are to be immediately opened (weather suiting), the bed-clothes removed from the beds, the beds shaken up, and with the bed-clothes, left open to the air of the window. The basins and the washing tables are next to be attended to; each article is to be properly cleansed, the jugs and carafes to be emptied, in order to be washed clean before they are refilled with fresh drawn water. When this is done, and the slops removed and emptied, the bucket washed out and placed so as to get dry, the beds are then to be made.

1574. "*Making beds*" is the term in daily use to express the re-arrangement of bedding or bedsteads after having been used. To *make beds* well is an art not unimportant to comfort, for it consists in shaking up the beds so sufficiently as to restore to the feathers within them all the elasticity which, from the pressure of those who have been sleeping on them, had been in a great degree lost. Unless well shaken, feathers adhere together and form hard lumps, which would prove uneasy and inconvenient to a healthy individual resting on them, but to invalids still more so; they would inevitably destroy the repose required by them.

1575. *To secure a bed being well made*, it is requisite that two persons should be employed to shake the feather bed, who, taking hold of its contrary corners, shake the feathers within it alternately from one corner to the other. This being done so as to convey the mass of the feathers towards the centre, the bed is then to be turned over, that side being brought uppermost which had been undermost the preceding night. If it is to be placed above the mattresses, it must be put aside or turned to the foot of the bedstead while the mattresses are turned over, in order that each side of them may be alternately used. The feather bed is then lifted upon it, and the feathers gently impelled by the hand from the centre towards the corners and sides, until they are equally dispersed within the case, which should form an even, level surface. The under blanket is then laid smoothly over it, and the under sheet is drawn from the foot of the bed and laid evenly across the bed, the seam of the sheet being placed exactly down the centre of the bed. The bolster, having been previously shaken between the persons employed in making the bed, is laid upon the upper end of the sheet and rolled neatly and tightly within it, and is then lifted close to the head of the bed, drawing up the sheet with it. The sides and lower end of the under sheets should at this period be carefully tucked under the bed, and especially at each end of the bolster, so as to fasten it up tightly within the sheet, preventing it thereby from being easily drawn off the bolster by any restlessness of the sleeper. The pillows are then to be shaken up and placed on the bolster, after which the upper sheet is to be laid on, as much of it being reserved at the bottom as will tuck well under the bed, so as to keep it straight; the rest of the sheet being drawn up to the head of the bed, is to be folded up neatly on the pillows, until the beds are to be turned down for use. The blankets are next to be laid over the sheets. The arrangement of these differs in some houses, for some persons prefer them to be laid so as not to be doubled down at the head of the bed, but to be turned up at the feet. They who require light covering over the chest and shoulders often need greater warmth over the feet, and hence housemaids should endeavour to remember which way is preferred by those for whom they are making beds. After tucking the blankets under at the sides and feet, and laying them properly, whether singly or folded, at the head, the counterpane is next laid neatly and evenly over, and the bed is made. In making beds with clean sheets, it is of no importance which ends of the sheets are put to the head or foot of the bed; but when once sheets have been slept in, they must be used always one way until they are again washed. As a rule by which to remember which way the ends of sheets were first laid, it is a good plan to put the marked ends of sheets always to the foot of the bed; also the inside of sheets should always be towards the sleeper, whom the rough edges of the seams might annoy. The laundress usually folds up sheets so as to prevent any necessity on this ground in the housemaid for completely opening them before she lays them on the beds. It may also be well to recommend a little attention from those who make beds to the feathers which escape from the case while the beds are shaken. If the housemaid fastens a small paper bag at the bed's head, in an unobserved place, she may easily collect the stray feathers each day, and enclose them temporarily in this paper bag; when the collection becomes considerable, all she has to do is to open a small part in one of the seams of the case, and to put them through it into the bed.

1576. *The hangings of four-post beds* are usually folded up and laid upon the bed, in the view of keeping them from the dust of the room. At night, when the bed-clothes are turned down for use, the curtains are drawn round either partially or entirely, according as the occupants of the beds are supposed to approve.

1577. *The hangings of tent beds* are usually looped up at the head and feet, and are easily let down to any required degree.

1578. *The hangings of French beds* are usually thrown back during the day over the frame of the bed, at least in England, for in France they are usually drawn closely round the bed for the purpose of hiding it from view.

1579. Before closing the subject of beds, we would add one or two remarks, chiefly, however, respecting the general care and management of feather beds.

Sometimes, either from the effect of damp or from neglect in shaking them, the feathers become permanently lumpy. In this case, it may be necessary to unsew the seam of the case sufficiently to admit the hand within, by which the lumps may be broken, and the buoyancy of the feathers restored. Beds become lumpy if allowed to get damp for want of use; it is therefore requisite to shake them up, when they are not constantly in use, as frequently as if they were in use, and whenever possible, they should be exposed to the rays of the sun, or to the warm air of a stove.

1580. *Housemaids*, when called into the room of an invalid to make the bed, should be able to do it so gently as not to disturb or irritate the patient, and yet so effectually as to render it as comfortable to him as his state admits of. If the patient cannot be lifted out of bed, then one half of it only can be made at once; but of which the feathers must be worked up with the hands and separated from each other with as little shaking as possible. They must afterward be equally dispersed within the bed tick by the gentle impelling of the feathers towards those parts that appear to be most wanting of them. Half of the under blanket is then laid smoothly over that part in which the feathers have been so far shaken. A clean sheet, half of which must be rolled up lengthwise, is then laid upon the blanket and arranged neatly over the bolster; the unrolled half of the sheet is left as flat as possible until the patient has been lifted over it, or his body so far raised as to allow of its being passed under him.

An invalid may sometimes be lifted from the part of the bed on which he has been lying to that recently shaken, by two or more persons lifting him between them by the sheet on which he lies, and thus partially swinging him to the part of the bed prepared for him; this being done, the sheet which is to be changed may generally be drawn away by very little aid given by the patient in raising his body slightly. The clean upper sheet must be rolled up across, that is, from each side, and being put under the upper sheet about to be changed, it should be gently unrolled by a person on each side, and drawn up towards the top of the bed, where it is turned down over the blankets. As soon as this is effected, the sheet under which it has been thus rolled may be easily and quickly drawn away. The rest of the covering may be made smooth, and, according to the feelings of the invalid, can be lessened or increased in weight. The other half of the bed is usually left to be shaken up the next time the invalid is to be removed, or the bed linen changed.

1581. *The housemaids' duties* being so far performed, their next employment is to prepare the bedrooms for sweeping, by covering the beds, together with the dressing and washing tables, over with the proper sheets, so as to keep them free from dust.

Then to hang high up the window and bed curtains, and to turn up the bed valances. The carpets, if consisting of small, loose pieces, are best taken up to be shaken out of doors; but if fastened down, it will be requisite to sprinkle tea-leaves over them, and to sweep them carefully with a *hair* or with a *Dutch broom* (the latter some ladies prefer to be used only once in the week, as too penetrating for daily use; they imagine the hair broom to be sufficiently strong to clean the surface of the carpet each day, and yet not harsh enough to wear away the wool, in the same degree as the more frequent use of the whisk or Dutch broom might do). The upper housemaid generally makes these preparations, while the servant under her fetches her brooms to sweep them. Into each bedroom and dressing-room the upper housemaid precedes her assistant, who, after sweeping one, follows her into the rest successively, leaving the upper housemaid to return to those rooms that have been swept, in order to dust the ledges of doors and windows, together with the furniture, to replace the curtains and valances, and to remove and fold up the wrappers that have been thrown over the beds and tables. After looking around in each room to see that nothing belonging to the housemaids' duties have been neglected, the upper housemaid then repairs to the linen press to look out and to air before the fire what may be required for the next day's use, or to see what articles want mending.

1582. *The under housemaids*, having each done her part, cleaned and put away pails and brooms, &c., are required one day in each week to assist in the laundry, and also, at proper intervals, to wash and get up their own linen.

1583. *The under housemaids* are also usually required to assist the cook in serving the dinner each day. When many dishes are to be ready at once, any hands in the house not otherwise occupied are, on occasions of large dinners especially, called to the aid of the cook, but with the serving, and generally the assistance of the housemaids, they are then expected to be in the still-room to receive, wash, and replace the china used at dinner: these may be termed their extra duties.

1584. *The repairing of the household linen and of the stockings* of the gentlemen of the family is not an extra, but an ordinary part of the housemaids' work, which usually fills up what leisure time they have until the period in which they must return to the bedrooms and dressing-rooms, in order to replace everything that had been used during the dressing time of the members of the family; and also to turn down the beds, and to close the windows, and draw the curtains. Any leisure time between this last branch of their employments and the hour of going to bed is usually allowed them for their attention to the repairs of their own clothing. In some families the housemaids are allowed two or more of the six evenings of the week for their own work.

The daily duties of the housemaid usually end with the closing up of bedrooms, and with the other preparations for the night. The upper housemaid usually carries hot water, both night and morning, into each room, and warms beds when it is required.

Weekly and occasional duties of housemaids.—Housemaids who understand how to arrange their work will avoid allowing any greater pressure of business in one week more than in another, but will be able to arrange and divide the general cleaning so as to make it not greater at any time than what may be easily got through. In great houses the families are often absent from home, and on such occasions the general cleanings to which we shall allude should take place.

Scouring of bedrooms should take place once in every fortnight or three weeks, according as the weather is favourable or the reverse to the subsequent drying of the wetted rooms. *The window sills* should be washed one day in the week. Brass handles to doors, or brass work of every kind, should be rubbed with a leather. Mahogany work should be well rubbed, and painted wainscoting and walls (not distempered) should have every spot and mark washed off with a sponge, and warm soap and water; finger marks on doors should be also removed in the same way

Once in a fortnight, paillasses and mattresses should be brushed with a clean hand-brush, so as to remove all lodgments of dust from the sides and from the tufts of wool where the fastenings down of the mattresses occur. *Sheets* are usually changed once in a fortnight in beds occupied by the members of a family, once every week in those of guests. Every fresh guest, of course, expects to find clean sheets on the bed allotted to him in the house of a friend.

1585. *In establishments in which one housemaid only* is kept, the whole of the business, as above described, she has to methodize and effect without much aid from other members of the household.

In a family of regular habits, she may probably have the privilege of going early to bed. It will then be only proper in her, and it will be certainly most convenient to her also, to rise as early as six in summer and not later than seven in the winter. With the opening of windows, and with preparing the sitting-rooms, as above described, for the renewed use of the family, she will, of course, begin her day. After hanging up curtains above the carpet, and covering over the sofas, &c., to preserve them from the dust, she must clean the grates, fenders, &c.; and when this is done, sweeping, dusting the rooms, and replacing the furniture aright must follow. Whenever possible, she should also sweep the stairs; for if deferred till late in the day, the family will be passing and repassing while she is sweeping them, very inconveniently both to themselves and to her.

1586. *In going into the bedrooms*, her first care must be given to the proper airing of the rooms and bedding. She must open the windows, and after removing the bedclothes from the feather beds, shaking up the feathers, and leaving them open to the air, she must proceed to set to rights the washing and dressing-tables, and then to cover them over in preparation for the sweeping. The bucket carried from room to room to receive the slops must be, when done with, emptied and immediately cleaned out with plenty of cold water, and turned down in an appropriate place to dry. It is a slovenly habit to leave the chamber-bucket long unemptied; it spoils the bucket, as it also does to leave it uncleaned and wet. When it is sufficiently dried, after it has been washed out, it should be put into the housemaid's closet, in which the rest of her utensils and materials for cleaning are usually kept. Two water-jugs should be among these utensils, one for hard or spring water, the other for rain or soft water. These being filled with a fresh supply, must be carried into each bedroom or dressing-room, out of which each ewer and carafe or water-bottle must be refilled. Towels that have been recently used must be dried either before an open window or before a fire, care being observed to replace each horse, with its respective towels, in the room to which it belonged, that there may be no exchange in the towels. When clean towels are to replace those which have been used, the housemaid should take care to dry those that are wet before they are put away for the wash. If left damp, linen will soon become mildewed, the marks of which are difficult to remove.

When the washing and dressing tables are put in order and covered over, the housemaid then calls to her assistance the other maid servants, whose duty it is to help her to make the beds. It is necessary to remind those who are called away from other employments to assist in making beds that they should previously wash their hands, and put off aprons which have been greased. Nothing can be more unseemly and disagreeable than marks of dirty fingers upon bed-hangings, sheets, or counterpanes; but with cleanly servants this can seldom happen. The beds being made, the curtains are to be shaken, folded, and laid on the bolster, and the valances to be turned up round the bedsteads. A large sheet is thrown over the whole, coarse wrappers over dressing and washing-tables, and the sweeping may then begin (see "Sweeping"): then she dusts every part and every piece of furniture; when the whole is completed, and she looks round and sees nothing neglected, her work is over for a time. She then resorts with her sewing to the still-room or kitchen, and sits there till it is time to put the rooms in order after dressing. In the evening she should pursue the same course as before mentioned. And during the week she should be solicitous to divide and arrange her work so as to get each day some portion of that done which may be termed the weekly business. By doing this, there would be no greater pressure of work on any one day more than on the rest of the week.

SUBSECT. 6.—*Duties of the Still-room Maid.*

1587. *The still-room maid*, less frequently required at present to assist at the still than in former times, when sweet-flavoured waters were to be prepared for the cook, aromatics for the dressing-room, and cordials for the invalid, yet she preserves her name, and in some houses her ancient avocations also. (See "Still-room," Book XX.) But whether these are entirely discontinued or not, she has always a distinct department to fill—that of the charge of the housekeeper's room. She is, in fact, the housekeeper's maid, lights her fire, cleans and dusts her room, prepares the table for her breakfast, waits upon her, and upon those of the establishment who breakfast with her, and, after clearing away the breakfast-table, she prepares to assist her in the preparations for second courses and desserts, or in distillation in those families in which this branch of the still-room employments is continued. Neat, clean, active, and obliging she must ever be, and if observant also, there is no office in a gentleman's house more likely to fit her for undertaking in time higher and more responsible departments of household business.

SUBSECT. 7.—*Duties of the Laundry Maid.*

1588. *The laundry maid* is engaged generally to wash and get up only the household linen and the family clothes. The maid servants wash for themselves, or receive instead an allowance of wages. The men servants' washing, with the exception of the footman's linen jackets and aprons, is always at their own cost. This is customary, and if it seem hard that the men servants should not have the same advantages in this respect as the women, it must be remembered that their wages are much more considerable than those of women servants. On this subject, see also Book XX., "Economy of the Laundry."

1589. *The weekly business of the laundry maid is the following*: on *Mondays* the business of the laundress begins with collecting and sorting out the various articles to be washed, in preparing the coppers, filling them with water, and laying the fuel ready for kindling. On *Tuesdays* she should rise at 5 o'clock, light the fires

under the coppers, and as soon as the water is hot, she should begin with her assistants to wash. As it is a main object to hang out early in the morning all articles (such as sheets and body linen) which may be improved by the whitening power of the morning air and sun, the first hours of the washing day should be diligently employed, and the evening, if the washing is finished, should be occupied with scouring and cleaning up the wash-house and the utensils which have been used. *Wednesdays*, the chief of the washing being completed, the business of drying and folding the linen for the mangle and iron is to be begun, as well as that of starching and clearing the fine linen. *Thursdays* and *Fridays* are occupied with mangling, ironing, and getting up the whole of the linen. *Saturdays* in separating it according to the marks affixed to it, and carrying each division into its appropriate place. The rest of the day is given up to the cleaning of the laundry, and putting into their places all things connected with the business carried on in it.

In families consisting of few in number, the laundry maid has often completed her business on Thursday evenings. She is then usually expected to assist the housemaid in repairing the linen either of the house or family.

SUBSECT. 8.—*Duties of Servants of All Work.*

1590. *A servant of all work*, though considered as holding one of the most humble places, may, if possessed of skill, activity, and integrity, be one of the most valuable of household servants, the comfort arising from the regular performance of the whole business of the house being solely dependant on her.

1591. *Generally, a young girl, on first going into service, commences her career as servant of all work;* and if she happen to fall into the hands of a clever, active mistress, she may be regarded as most fortunate; for, under her direction, she may prepare herself admirably for any other department of service. She cannot be in a better school for her education in household duties and virtues than in a family of orderly and neat habits, in which each day's occupations proceed in a regular and almost undeviating course. But, unfortunately, it is frequently the reverse; and a girl of unformed habits often finds her first service one of hard, yet irregular duty. If she entered it possessing any notion of order and neatness it is soon lost, and she falls readily into the habits of mismanagement and carelessness of the examples before her, habits which probably will affect her welfare to the end of her days: once contracted, they are seldom eradicated. In hiring maid servants to fill distinct departments in larger establishments, objections are often raised against those who have only served in the general character of servant of all work, objections arising from observations on the irregular management of their household duties, and their deficiency in neatness. It must, however, be remembered that a *good servant* of all work will make a good servant in any capacity, and may be taken into any department, not only without fear of her failure, but with every probability that she will fill the situation with credit to herself and with satisfaction to her employer. In some places, Scotland for instance, a *good general servant*, as she is called, is much sought after, and can demand higher wages than those who engage in only one department of service.

1592. *The routine of the duties of the general servant* depends chiefly upon the description of place she enters. Suppose her engagement is to serve a single lady in a small house in a town. Here her work will probably be regular, and not so heavy, but that with industry, activity, and a judicious division of the work, she will be well able to perform it. First, she must be an early riser; before her mistress gets up, her kitchen, parlour, and hall should be properly cleaned (see art. "Cleaning"), and she herself washed and neatly dressed, ready to attend on her mistress and to prepare her breakfast, taking her own also about the same time. After breakfast, and after washing and putting away the breakfast things, and receiving her mistress's orders for the day, she should repair to the bedrooms, and proceed to clean and arrange them, as described above (see "Housemaid's Duties"). From these employments it is probable that she may be occasionally called away to answer bells; and, on such occasions, she should look to her kitchen fire now and then, to keep it in readiness for the cooking, to which she will, in a short time, have to attend. When up-stairs work is done, she must return to her kitchen, and set about preparing the dinner. In some cases the mistress may, perhaps, assist her. It will be an advantage to the servant to have such an assistant and instructress who may be clever in the art of cooking.

1593. A mistress capable of directing the business of the kitchen and house is the best friend a young servant can have. Before dinner is served she should again wash her hands and change her apron, making her dress as seemly as the nature of her employments permit. In a service such as the one now described, the family usually dine first, and the servant afterward, on the remains of the dinner. As she brings it from table she should put it near the fire to keep it warm until she has time to sit down to it. If she does her duty to her employer, she may conscientiously attend to any little circumstances that may promote her own comfort.

1594. Her dinner over, the clearing away, scouring saucepans, washing dishes, with every other necessary act of cleanliness, will occupy some part of the afternoon, in the course of which she must find time to make up the kitchen fire, set on the tea-kettle, and sweep up the kitchen hearth. Her work completed, she again washes herself and changes her dress; she is then ready to wait upon her mistress at tea, and to attend in any other way to her comfort.

1595. The evening is occupied with closing doors and windows, and arranging the bedrooms for the night.

1596. *Besides the daily routine, she must contrive to bring into each day some portion of the weekly cleaning.* Her kitchen should be scoured twice a week, on *Wednesday* and *Saturday*; the parlour swept every other morning; the hall washed; bedrooms swept, and carpets taken up and shaken on *Tuesday* and *Friday*; *plate* cleaned on *Wednesday* and *Saturday*; block tin kitchen utensils, plated candlesticks, and brass work on *Thursday* (see "Cleaning"). Once a fortnight, or once in three weeks, the floors of bedrooms should be scoured (see "Scouring"), marks on painted wainscots washed off, windows cleaned, &c.

1597. *If the washing be done in the house*, the above routine will be occasionally broken into for a few days, though probably she will be allowed some assistance at the washtub, and will find her mistress ready to take on herself some portion of the lighter business of starching and getting up the fine linen.

1598. Although a multiplicity of occupations appear to claim her attention and time even in the smallest families, yet, by a judicious division of her duties, and by activity and diligence, she will find them all under her command, so as to get through them without any inconvenient pressure. In the appropriation of her occupations to time, and in the steady, regular performance of the same, consist the good management of the *servant of all work*.

1599. The following is given as the usual wages of domestics:

MALE DOMESTICS.					FEMALE DOMESTICS.				
	Out of Livery.		In Livery.			Rate of Wages, including the Allowance for Tea and Sugar.		Rate of Wages, where Tea and Sugar are allowed.	
	Highest Wages.	Lowest Wages.	Highest Wages.	Lowest Wages.		Highest Wages.	Lowest Wages.	Highest Wages.	Lowest Wages.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.		£ s. d.	£ s. d.	£ s. d.	£ s. d.
House steward .	75 0 0	50 0 0	0 0 0	0 0 0	Housekeeper . .	42 0 0	26 5 0	36 15 0	21 0 0
Valet	47 5 0	31 10 0	0 0 0	0 0 0	Lady's maid . .	26 5 0	14 14 0	21 0 0	12 12 0
Butler	50 0 0	42 0 0	0 0 0	0 0 0	Upper nurse . .	31 10 0	15 15 0	20 0 0	10 10 0
Cook	40 0 0	30 0 0	0 0 0	0 0 0	Under nurse . .	16 16 0	10 10 0	12 12 0	10 10 0
French cook . .	150 0 0	100 0 0	0 0 0	0 0 0	Nursery girl . .	8 8 0	6 6 0	6 6 0	4 4 0
Porter	0 0 0	0 0 0	20 0 0	18 0 0	Cook	31 0 0	16 0 0	20 0 0	10 10 0
Footman . . .	42 0 0	31 10 0	25 0 0	18 18 0	Kitchen-maid. .	14 14 0	10 10 0	12 12 0	8 8 0
Under footman .	0 0 0	0 0 0	21 0 0	16 16 0	Scullion . . .	9 9 0	6 6 0	8 8 0	4 4 0
Foot-boy . . .	0 0 0	0 0 0	14 14 0	8 8 0	Upper housemaid .	16 16 0	10 10 0	12 12 0	8 8 0
Coachman . .	0 0 0	0 0 0	31 10 0	21 0 0	Under housemaid .	10 10 0	8 8 0	9 9 0	6 6 0
Groom	36 16 0	26 5 0	21 0 0	16 16 0	Still-maid . . .	10 10 0	9 9 0	9 9 0	7 7 0
Postillion . . .	0 0 0	0 0 0	21 0 0	16 16 0	Laundry maid .	16 16 0	12 10 0	14 14 0	10 10 0
Stable-boy . .	0 0 0	0 0 0	12 12 0	8 8 0	Wet nurse . .	31 10 0	20 0 0	26 5 0	18 18 0
Gardener . . .	50 0 0	20 0 0	0 0 0	0 0 0	Maid of all work	14 14 0	9 9 0	12 12 0	7 7 0

[In the United States the progress of luxury and extravagance has happily stopped short of the multiplication of servants to the extent which, as here truly represented, the British aristocracy and nobility have reached. Even among our *millionaires* there are none who retain so many male and female domestics in their home establishment. Although, in the Southern States, there are many planters who have hundreds of slaves, of whom they are the legal owners, and who are chiefly employed in their cotton and rice fields, or in their sugar and tobacco plantations; yet none even of these include in their household proper so many as 28 male and female attendants, nor are there any in the non-slaveholding parts of the country who employ half that number, however extensive their domestic establishment. Indeed, some of the official designations of servants here named are not recognised in America even by our English residents, many of whom do, nevertheless, retain many of their British notions and accustomed habits; but they find it impracticable to obtain competent and trusty servants in all these departments, however they might desire it.

Of male servants, our wealthiest families retain no more than a porter, footman, coachman, groom, gardener, waiter, and, in some few instances, a French cook, butler, and valet; and the housekeeper, cook, scullion, lady's maid, chamber-maid, laundry maid, nurse, and one or more maids of all work, constitute the whole of the female servants employed in the most extensive domestic establishments in America. Nor is it at all common to have any of the servants in livery except, in rare examples, the coachman, footman, and valet. Indeed, a vast majority of the wealthy merchants and capitalists of our country content themselves with less than half this number of servants, and find their household duties better attended to by requiring the most of their domestics to be servants of all work. The difficulty of procuring persons in this country who have been trained for special departments of domestic service would, of itself, be an insuperable obstacle to procuring an analogous classification of servants to that described above as common in England, unless they were imported for the purpose; and the rate of wages is so much less in America than in England, that no inducement could be held out sufficient to lead such to emigrate thither.

The mass of our population in the United States, however, have been trained to help themselves in the management of household affairs to an extent which renders them independent of so many servants, nor do they feel the need of them. The wife and mother, in multitudes of reputable and even wealthy families, prefers being her own housekeeper and nurse; the elder daughters consult their taste, and promote their health by attending to the chambers and cultivating the skilful use of the broom and hand-brush, or, where there are no elder daughters, some female relative, who becomes an inmate of the household, attends to these duties of choice. A maid of all work, or two or three of such if needed, together with a cook and washerwoman in the kitchen, with a servant to run errands, &c., are all the female servants kept or needed by very many of our most reputable and wealthy families; while one or two servants of all work are all the female help which a majority of American families retain.

Male servants, either white or coloured, are only employed by the wealthy, or those who choose to be reputed such, and are hence comparatively rare, especially in the non-slaveholding states; and a waiter or valet, a footman and coachman, constitute the number seldom exceeded. In most families these are dispensed with very readily, menial offices of all kinds being performed by public porters, bootblacks, barbers, washerwomen, &c., who, acting as outdoor servants, attend to these respective duties for a weekly or monthly stipend. The livery stables conveniently provide a stable-boy and groom, where a carriage and horses are kept, and multitudes of gentlemen choose to drive

their own carriages when they give their families an airing, rather than to confide this trust to a coachman, often careless, and even drunken. Apart from the economy of these arrangements, Americans greatly prefer them in the general, and their commonness renders them reputable even among the higher classes, who thus rid themselves of the expense and, what is worse, the annoyance of so many servants.

The greatest trouble connected with housekeeping in American cities is, confessedly, the difficulty of procuring and retaining good servants, and private hospitality, to which our people are proverbially disposed, is necessarily limited by this circumstance; and it is one the annoyance of which can scarcely be appreciated, and, though not easily described to strangers, may be readily accounted for.

In the Southern States, where slaves are trained by their masters and mistresses with special reference to the service of the family in the department of labour allotted them, the difficulty of which we speak is not realized to any great extent. Servitude is their lot, as it has been that of their ancestors, and they are, for the most part, ignorant of any higher destiny being attainable or even desirable; and multitudes of them are contentedly happy, and free from any aspirations after a change of their condition, which, though one of bondage and dependance, is attended by no care or anxiety for the means of subsistence, which with them is the ultimatum of desire.

But in the non-slaveholding states, and especially in the northern cities, the case is widely different. The coloured people are free, and when they can find any employment, however menial, which they can conduct on their own behalf, they refuse to become hired servants, or the domestics in families, regarding such service as beneath them, approaching, as they seem to think, to the nature of slavery. And of those who are compelled, for want of subsistence, to enter domestic service, it is their misfortune more than their fault to say that, for the most part, they are mere eye-servants, and are not often found either qualified or trustworthy.

Their number being very inconsiderable, our population in the North have to be mainly dependant on the Irish and German emigrants, who constitute the great mass of our domestics; for most strangely it has come to pass that white females, especially in the humble walks of life, however humble, regard the condition of hired servants as beneath them, and the domestic duties of the household too degrading for freeborn Americans! They prefer harder labour, coarser fare, and destitution of a comfortable shelter, if they can only be seamstresses, tailoresses, hat and shoe binders, book-folders, shopkeepers, milliners, or anything else except the hired girls, helps, or domestics of a family. Multitudes of them in all our cities toil from Monday morning until Saturday night in miserable garrets, hovels, and even cellars, working at prices which stint them for even the necessaries of life, wither their health, dim their eyes, and often sacrifice their lives, who might be actively and healthily employed in the bustling duties of domestics, at ample wages, with the comforts and even luxuries of life, and a good home. But such is their infatuation on this particular subject, that very few American girls, of suitable age for household service, can anywhere be found in the capacity of domestic servants.

It is for this reason that Irish and German domestics are almost universally employed in the northern cities, and these are, for the most part, wholly uninstructed in the duties of household service; and however willing multitudes of them are to work for hire, they have to be taught by the mistress of the family even the most common kinds of service, being, for the most part, wholly ignorant of the plainest cooking, house-cleaning, washing, ironing, &c., so that they often receive wages for months before they begin to make themselves useful in the family, or can at all be relied on for their every-day routine of duty.

By this time they often become corrupted by the intercourse they have with other servants during their frequent leisure, and are prompted to demand an advance of wages, and to make exactions of time for visiting their numerous cousins and other relatives from the old country, as well as to fill your kitchen with strangers, both male and female, until the annoyance becomes insufferable. Next they abruptly leave the family where they have been taught at great pains, and have but just learned the work they are required to do, either to seek a nurse's place, or some lighter form of service, for higher wages, or, perhaps, to get married to some one of their countrymen, whom you have allowed to quarter upon your premises rather than risk the loss of your servant, now that she has learned how to be useful. These are but a few items in the list of grievances which are perennially multiplied.

To remedy these and similar evils, societies are formed for the encouragement of faithful domestics, by whom premiums are given to those who continue to serve any family for a reasonable length of time, and testimonials of good character issued which secure them a perpetuation of employment. These useful institutions, however, are comparatively inefficient, for the reason that few out of the mass of servants are found to merit their rewards, either from a roving disposition, or mistaken notions of independence, with which they become filled in this "free country," where they seem to expect the most wages for the least work, and calculate to be well paid for doing as they please.

The only adequate protection to housekeepers from the endless troubles connected with their domestics is to be found in correcting the mistaken idea among our own young countrywomen, that there is anything degrading in the routine of domestic service, or that it is less respectable to labour at household duties for hire than to toil with the needle for the miserable pittance which speculators in female servitude allow such to receive as wages for their industry.

A young wife whose condition in life before her marriage has exempted her from the drudgery of the kitchen at her paternal home, and whose husband is in circumstances entitling her to similar exemption in her new relation, is, nevertheless, obliged to perform menial duties in her kitchen, not only to instruct her first servant, but she has to give similar lessons to every new servant which her frequent changes introduce into the family. However unwelcome such labour, no one imagines that it is in the least degree disreputable, after her marriage, to teach her servants by practical lessons, or to assist them statedly in the duties of the chambers or kitchen. And yet the same duties and toils, cheerfully performed after marriage by the mistress, and to which she has never been accustomed, are deemed by young women dependant on their labour for bread as beneath their fancied dignity; and pauperized seamstresses, &c., ground into the dust by their taskmasters, whose compulsory bill of prices fail to reward their hard earnings with even the necessaries of life, will turn up their noses in aristocratic pride by excluding from their society a young woman who is occupied in domestic service, either as kitchen maid, or servant of all work, and this though the lady of the house herself shares in the humblest of her labours.

How insufferably absurd is such folly, when this same seamstress, when she has luckily married some labouring man of her own degree in life, enters upon housekeeping for herself without a servant of any kind, and becomes reconciled at once to those very kinds of labour which she before regarded as humiliating and disgraceful; and when, by dint of industry and frugality, the young couple find themselves able to look out a servant to relieve the wife of her daily task, and share the burdens of an increasing family, she finds her former notions of the degrading character of domestic service so universal among her own countrywomen, that she is now convicted of her infatuation, and is compelled to take under her roof a raw Irish or green German girl, neither of whom know how to boil a potato or cook a beefsteak until they serve an apprenticeship in her kitchen.

Under such circumstances as here alluded to, it is obvious that the classification of servants recognised in England is impracticable in America. And, moreover, the high notions of equality and independence inspired by a "free country" would render such an army of servants in a household as unmanageable as a regiment of dragoons, and as dangerous to the peace and safety of a family as a "gunpowder plot." Indeed, there are very few in this country whose income would justify so large an outlay for domestic wages as the foregoing table shows, nor is there any family establishment for private residence in America which could furnish occasion for so many servants. The foregoing chapter, however, possesses much interest, and in the comparison of this feature in our domestic economy with that of England, will furnish our countrymen no cause for dissatisfaction or envy.]

CHAPTER II.

HOUSEHOLD CLEANING.

Sect. I.—GENERAL HOUSEHOLD CLEANING.

Subsect. 1.—*General Observations.*

1600. *Cleanliness, whether household* or personal, may be considered as one of the unalloyed advantages derived from civilization. If it may not be ranked as a virtue, it is, at least, the parent of virtues, and not unadvisedly was the old saying first pronounced, "Cleanliness is next to Godliness."

1601. As a habit, it has moral as well as physical advantages, personal as well as domestic; hence its claims on our approbation and daily observance. It evinces an absence of slothfulness; for, without activity and exertion, cleanliness cannot be practised: it is an emblem, if not a characteristic, of purity of thought and propriety of conduct. It seems as if it could not be associated with vicious pursuits, so rarely, in the habitually profligate character, are the active and wholesome habits of cleanliness perceptible. The squalid wretchedness which sometimes engages the pity of the philanthropist is oftener found, on investigation, to be the effect of vicious idleness rather than of unmerited misfortune; while cleanliness, if it cannot totally indemnify us from the evils of poverty and disease, can keep them far removed from utter wretchedness and misery.

Cleanliness is an unequivocal good; and, accordingly, we find that it confers a spe-

cies of rank on all its votaries, to whatever class in the scale of society they may belong. The cleanly family, whether living in the cottage or the hall, is "respectable," "creditable"—a distinction which serves as capital or stock in trade to members of the industrious working class, and is not without its value in the higher walks of life, where honour and distinction are sought.

1602. In the former class, the respectability of a family (and we can scarcely allow respectability to be claimed where cleanliness does not prevail) is a sufficient recommendation to honest and creditable employments. An opposite term, given to an idle, slovenly family, would be an equal impediment to the worldly advancement and welfare of its members. Doubt and suspicion must inevitably cloud the prospects of all whose domestic habits could not promise for them that, in the world, when called upon to act, they would be diligent and energetic, not self-indulgent, or wanting in attention to any of the proprieties of life.

1603. *We shall first consider cleanliness in the house*, together with the *modes* of cleaning everything within its walls. Attention to the person will be treated of elsewhere. Under the head of "Ventilation," we have treated of the importance of preserving the purity of the air in our houses, and of those causes which deteriorate, among which the want of cleanliness is one of the chief.

1604. Whatever may be the exciting causes of infectious diseases, cleanliness has in its keeping the specific by which their progress is checked. Under its influence infectious complaints are often confined to some solitary instance in a family, and do not spread, as formerly they would have done, with the fatal rapidity of a pestilence. This specific allays the scourge, as well as giving exemption from contagion to all who practise it. Many other effects of cleanliness on health might be stated, with considerations of much importance in other points, relative to family comfort and prosperity.

1605. The economy of cleanliness is another recommendation to its observance; the uniform cleaning of house and furniture is among the best means of preserving both: we can neglect no wholesome practice in the whole cycle of domestic cleaning without inflicting an injury on some part of our property. We may even incur an entire loss by neglecting to clean in time some of the various articles of furniture which comfort and convenience require us to possess; so that to the other evils of uncleanliness we may fairly add that of *waste of property*. Thus, on domestic cleanliness how much depends! *comfort, economy, health, and respectability.*

1606. It must be acknowledged that, in this country, *the taste for cleanliness*, if the term be permitted, has long been cultivated, although there may be room still for improvement in it, as its universal prevalence depends upon the cultivation of more qualities than one.

1607. Yet here we must observe that, indispensable as the practise of cleanliness is, like many other good inclinations and habits, it may be carried too far. It may encourage an inconvenient fastidiousness, a nicety that must often be offended, and a consequent tendency to irritation of temper. Such effects would, in some degree, counterbalance the advantages of cleanliness.

1608. *There are families and situations* in life in which cleanliness can only be practised in generals, not in details; in such cases the love of it should be kept within the bounds of possibility, or it may become a daily cause of family uneasiness and discord. We delight to see the supremacy of cleanliness, its victory over dirt and smoke; but it can only yield such pleasure when known to be the result of a practical, orderly, and regular system, and not of the severe, hard, daily duty which we imagine to be the characteristic of an enslaved existence. Cleanliness, like every other good quality, must have its prescribed limits. If these be overstepped, it may prove a torment and inconvenience, instead of one of the sources of domestic enjoyment.

1609. We now proceed to such details respecting the practical part of our subject as may enable a mistress of a family or her housekeeper to form her system of household cleanliness, and to direct its daily course.

SUBSECT. 2.—*Cleaning Floors.*

1610. Floors of a house may be of several kinds — of boards, of brick, and of stone.

1611. *Boarded floors* are commonly either of *oak* or *deal*. The former, chiefly seen in country houses, or in the residences of the opulent, forms an excellent, substantial flooring, and is often only partially covered with carpet. Deal floors, on the contrary, are almost uniformly and entirely carpeted, except in the apartments assigned to children and servants: the mode of cleaning them is, consequently, of less moment, and less laborious than that employed in cleaning floors of oak.

1612. *Scouring*—for which the housemaid must be provided with a good-sized wooden pail for water, a wooden bowl for sand, a piece of flannel rather more than half a yard square, and a hard scrubbing-brush—consists in scrubbing floors with the brush, some sand, and clean cold water, and afterward in washing off the sand with the flannel. *Soap* is sometimes used with sand; but, instead of improving, it injures the colour of the boards when dry, giving them a blackish appearance.

1613. *In scouring*, the housemaid first dips her brush in the water, then sprinkles it with sand, and scrubs, with force, such portions of the floor as her arms can reach at a time. From these she washes off the sand

with the flannel, drying and completing each portion at once, so that she need not tread over the boards until they are dry. *In bedrooms* it is desirable to scour first the boards beneath beds, chests of drawers, or wardrobes, that these parts, being less open to the air than others in the room, may have the more time to dry. When bedrooms and nurseries are scoured in the winter, and when the windows cannot be long open on account of the weather, it is very prudent to have fires in each room to accelerate the evaporation of the moisture on the floors. The damp arising from newly-scoured boards is as likely as any cause whatever to encourage the inflammatory diseases of childhood, or the coughs of individuals subject to them.

1614. *For scouring, when necessary to be done in winter*, dry clear weather should be chosen. During very frosty weather it ought rarely to be done, the evaporation not being then rapid enough to carry off the moisture of the boards; or if it freezes on the boards, which is sometimes the case, it then requires two days, instead of one, to dry the room thoroughly.

1615. *Deal boards*, if not carpeted, should look white and clean; they may be improved, if the colour be indifferent, by the use of fullers' earth or pearlash dissolved in the water. In the use of clean water the housemaid should not be sparing; whenever it begins to look dark-coloured and becomes thick, she should instantly carry it away, and bring a pail of clean fresh water to her task. If she does not change the water frequently, she will smear and not clean the floor. *Scouring, in most houses, is usually done at stated intervals*; in nurseries and offices, generally every week; in bedrooms, every fortnight, or once a month, according to season and situation; in sitting and eating rooms, which are carpeted, scouring is not done more than once or twice in the year, nor need dry-rubbed oaken boards be scoured more than once in twelve months.

1616. *Oak boards*. The effect of scouring oak boards with soap and water is to bring them to a dirty, dull white colour. To prevent this, the boards, after being scoured, are washed over with water, coloured either with *umber* or *yellow ochre*. With old boards, the umber is most commonly used; with new oak floors, the ochre. After the scouring and the washing with the coloured water has been done, the most laborious part, that of polishing, called *dry-rubbing* the boards, remains to be accomplished. For this work, the housemaid must have a large, heavy, hard brush, in length one foot or more, in width about eight inches, affixed to a long stake or handle. With this brush, and a little hot, dry sand, she must scrub the floor to and fro the way of the grain, until the polish, destroyed by scouring, be restored. Sometimes bees' wax is used to accelerate the reappearance of the bright surface; but bees' wax, in restoring the polish, at the same time renders the boards so slippery as to make walking on them scarcely less dangerous than on ice. Friction alone will, by frequent repetition, brighten the boards sufficiently, without the inconvenience of making them slippery also. After the *dry-rubbing* is over the sand is swept away, and for the next ten or twelve months these boards will only require sweeping every day, and a little dry-rubbing once a week.

1617. *In France*, where carpets are less commonly used than in England, oaken floors are seen in most of the great houses and in hotels. They are kept in a highly-polished state by men, the work being there considered as too laborious for women. The men perform this duty with their feet, to one of which they fasten the brush; and with great activity, and without much apparent fatigue, they soon bring a glass-like surface to the floors. They employ wax and other polishing substances to hasten their work.

1618. *For removing spots of grease* from boards, take equal parts of fullers' earth and pearlash—a quarter of a pound of each—and boil in a quart of soft water, and, while hot, lay it on the greased parts, allowing it to remain on them for ten or twelve hours, after which it may be scoured off with sand and water. A floor much spotted with grease should be completely washed over with this mixture the day before it is scoured. *Fullers' earth* and *ox-gall* boiled together form a very powerful cleansing mixture for floors or carpets. *Spirits of turpentine*, rubbed for a short time forcibly on grease spots, dissolve the grease in the floor, and make it readily unite with pearlash or soap, with either of which the parts should be afterward washed. *Drops of tallow* may be scraped off. *Stains of ink*, dried in on floors, are difficult to eradicate. Strong vinegar or salts of lemon will remove them. *Red wine stains* on boards may be removed by laying on them a strong solution of soda. If this be not sufficient, *the chloride of lime* or bleaching liquid, sold by chemists in half pint bottles, will remove them.

SUBSECT. 3.—*Cleaning the Sides of Apartments.*

1619. As oil paint is injured by too frequent scouring, it is necessary to use every means which may render the scouring of paint rarely needful; first, by cleaning the walls, edges, and mouldings from all lodgments of dust, frequently sweeping and daily dusting them with the proper hair broom, called the *Turk's head*, over which a clean linen duster should be tied. Every angle, the favourite nook of the house-spider, should be cleared, as well as the panels and ledges of doors. In sweeping the mouldings of the ceiling cornices, great care must be taken not to break them, they being made of plaster, and consequently brittle.

1620. *Partial washing of spots and stains on oil paint* may prevent the necessity of more frequent general scourings. Every week the housemaid should examine the paint, and remove with a flannel and soap and water any spots upon it, finger marks, &c., within her reach; having wiped them away with the flannel, taking care to wipe those parts dry, so as not to leave it visible where the cleaning has been done.

1621. *In washing or scouring paint* little soap should be used, the alkali of the soap having a tendency to injure oil paint. But water alone is not sufficient. After scouring with the brush and soap, plenty of water should be used to wash off what remains of the soap; otherwise, if left on the paint, it will cause its decay.

1622. *Oak wainscot* should, when necessary, be washed only with a sponge and warm water; after which it should be rubbed with a brush, like mahogany.

1623. *Stairs* in towns are frequently painted in oil, either white or of stone colour. The parts which are not covered with carpet should be washed weekly with warm water and two sponges; one to wash, the other to dry the stairs with: by using sponges the edges of the stair carpet are not so likely to be injured, as by a brush or scouring

flannel. *Painted stairs* look clean and neat while the paint remains on them; but the paint requires to be renewed almost every second year.

1624. *When walls are painted in distemper* (see Book I., Chap. VI., "Painting"), they will not bear the application of water, and therefore admit of no cleaning except that of sweeping down gently from them all the dust that may adhere to them.

1625. *Paper-hangings* of walls also admit of very little cleaning except that of sweeping them down with the hair broom, covered with a clean linen duster. Stains by smoke may sometimes be cleaned by rubbing them with the crumb of a loaf. *Grease* can scarcely, by any means, be removed from paper-hangings.

1626. Whenever a room is fresh papered it is desirable to reserve small pieces of it, that repairs may be made in the case of any part being torn off or injured.

Subsect. 4.—*Cleaning Marble and Stone Work.*

1627. *Marble floors, chimney-pieces,* and *hearths* are simply washed with a flannel or sponge, and soap and water, and wiped dry with linen cloths. If stained either with oil, wine, or discoloured with smoke, other means must be employed to clean them.

1628. *Oil* or *other grease* dropped on marble or stone may be removed by laying on the stains a mixture of *strong soap lees* with fullers' earth and pipe-clay well dried and powdered. When laid thickly on, a flat iron, made tolerably warm, must be put on and suffered to remain until the mixture is dried; and if on washing the part the stain be not eradicated, the mixture and iron must be applied either once or twice more.

1629. *Stone floors* and *stone stairs* are sometimes scrubbed with sand and water, sometimes with the hearth-stone, or with pipe-clay prepared after the following receipt:

Boil half a pint of size with the same quantity of whiting and pipe-clay in two quarts of water; the stones must be first washed clean with water, and this mixture afterward laid smoothly on them with a flannel; when dry, they must be rubbed with a dry cloth or flannel.

Stone floored kitchens and offices, stone hearths, stone steps, and balconies are usually washed with a flannel and water, and, while wet, scrubbed with the *hearth-stone.*

Steps at the entrances of houses are washed and whitened every day in town, in the country scarcely more than once a week; stone kitchens twice a week, balconies only once.

Subsect. 5.—*Cleaning Areas, Dust-holes, &c.*

1630. *In the areas of town houses,* together with the offices opening into them, cleanliness is as requisite to the comfort, and perhaps health, of a family, as in the interior of a house.

1631. *The dust-holes,* often opening into one of the areas of town houses, and being thus in close vicinity to the windows, cannot be suffered to remain long unemptied without considerable inconvenience, especially in the warm seasons of the year, when the fermentation, both of the vegetable and animal substances, produce noxious exhalations. On this account, it should be a rule not to throw any animal or vegetable substances into the dust-hole, but to dispose of them some other way.

1632. *In London,* parochial arrangements are established for clearing away from every house all its refuse at short intervals.

1633. The men employed in this business are not entitled to any direct remuneration from the inhabitants, their services being paid for by the contractors who employ them. But they often refuse to remove any unusual degree of rubbish in the shed-hole without being paid for it. It is well to know that they have no right to this, and a redress may be had by applying to the contractor himself.

Subsect. 6.—*Cleaning Windows.*

1634. *In large towns it is usual to employ glaziers* to clean the windows; and they being used to the business, do it most effectually and expeditiously; *the mode is,* first to dust them with putty-powder (sold at the oil shops under that name), enclosed in a linen bag, afterward rubbing it off with two wash leathers, one a little damp and the other perfectly dry; a sponge and cold water and soap some employ; but the panes, if wetted, are seldom so thoroughly and immediateiy dried as not to catch the dust again almost as soon as it has been cleaned off.

1635. To clean windows expeditiously, two persons should be employed, one within the room the other on the outside the window, the latter standing securely on the glazier's machine, unless the sashes are double hung, in which case the upper windows may be cleaned while the outside person merely sits on the sill, his legs being within the room, and his back to the street; but this is a dangerous practice for any one to attempt except a professed glazier.

1636. *Uncleaned windows* give a dismal and untidy appearance to a house.

When the cleaning of windows is to be paid for each time, there may be considerations of economy to be attended to which may prevent its being done as frequently as would be otherwise agreeable and desirable. Where no such reasons determine the periods of cleaning windows, it should be done in most of the rooms once in a fortnight. Where men servants are kept, and great attention to appearance paid, sitting-rooms should

have their windows cleaned once a week, and even more frequently in rainy weather. Those who have to pay a glazier each time, who generally charges 6d. each window, if he clean both inside and out, content themselves with having it done once in three months, trusting to their housemaid to keep them in tolerable condition, which she may easily do by frequently cleaning the inside of the panes.

SECT. II.—CLEANING ROOMS AND FURNITURE.

SUBSECT. 1.—*Sweeping and Dusting.*

1637. *Sweeping* is an art of a simple nature, but which to do well requires practice and care. The broom, in the hands of a thoughtless girl, may do more harm than good, by raising the dust from one lodgment only to send it into another, instead of rolling it gently along until a mass is collected sufficient to be swept into the dust-pan and carried off. Before beginning to sweep, the housemaid should close the doors and windows; and, by throwing sheets over the furniture of the room, protect it from any lodgments of dust.

The floor, whether carpeted or uncovered, must be with prodigal hand sprinkled over with moist tea leaves. Let the housemaid remember that the tea leaves should not be mouldy, or they will impart no pleasant freshness to the air of the room, nor dried, or they will be useless in catching the dust. Taking her broom, she must first sweep gently the dust collected under the furniture, beds, drawers, &c.; and, when sweeping in the open room, she should avoid lifting her broom hastily or high above the ground, which would impel the dust upward, but she should endeavour to check its rising, while she quietly and gently rolls the mass of leaves and dust into one spot, from which she can most readily sweep it into her dust-pan.

1638. After sweeping, the essential work of *dusting* should be done. The window-curtains, which had been lifted up considerably above the floor during sweeping, should now be released, opened, shaken, brushed with the proper brush, and properly arranged over the hooks or bands for the day. Tables, sofas, with all the varieties of chairs and seats now in use, are then to be carefully dusted and arranged. Ledges of wainscots, panels of doors, and window panes must be swept with the small brush called the *banister brush*. Mirrors, and pictures with gilded frames, must be brushed with *feathers* or *silk dusters*. A linen rubber spoils them.

1639. Chimney-piece ornaments must be carefully removed, and the mantel-piece either wiped free from dust, or washed with soap and cold water; the ornaments, before being replaced, must be carefully wiped with a fine linen duster.

1640. Sweeping is, in most country places, a daily business, neither bedroom nor parlour being considered as properly done if this be neglected. In London, where the necessity for sweeping daily is still more urgent, it is customary to sweep the bedrooms twice, and the sitting-rooms only once a day.

1641. Under beds, wardrobes, and other immoveable furniture every particle of dust should be cleared away each day, either by employing a clean damp mop kept for the purpose, or a damp scouring flannel.

1642. *For sweeping boarded floors, the common hair broom* is used, which costs in purchasing from 3s. to 4s.

1643. *The carpet broom, or whisk brush,* is made of the dried leaves of a tough grass.

It is not desirable to sweep the carpet with this broom more than once a week, being rather too harsh for daily use. But after a carpet has been well swept with it, the common hair broom will keep it sufficiently clean for several days. The *drugget brush*, a short-haired broom, answers for stair carpets, and for rooms covered with drugget.

SUBSECT. 2.—*Cleaning and Preservation of Carpets.*

1644. *Carpets,* thirty or forty years ago, were regularly taken up during the summer months, and, after being well beaten, were rolled up and deposited in some convenient part of the house till autumn; the floors, in the mean time, being only partially covered with oil cloth or matting. This custom rendered *scouring* and *dry-rubbing* matters of more importance than they are at present, when sitting and even bed rooms are generally entirely covered with carpets at all seasons during which a house is occupied by a family; but it is requisite to have them occasionally taken up from the floors and well beaten, if possible, in the field.

1645. *The periods* at which this beating of carpets should occur must depend on the convenience of every family.

1646. *Drawing and dining room carpets* are, in some houses, taken up and beaten twice in the year, in the spring and autumn; in others only once, under the idea that the frequent beatings weakens the texture of the carpet. The best mode by which frequent beatings might be avoided would be to turn the carpets up once a week and sweep under them; but the manner in which they are now universally fastened down renders this next to impossible.

1647. *In former days, carpets* were not made to cover the whole room, as at present, and which renders it necessary for them to be closely and firmly united to the floor, but were wove, as the turkey carpets and Axminster still continue to be, square, or nearly so; and, being loose, could, without much additional trouble, have the dust which collected beneath them frequently cleared away; which, with the floors, being oftener washed than at present, tended materially to preserve cleanliness in the texture of the carpets.

1648. *Bedroom carpets* it is desirable to have made in such a manner as to admit of being frequently taken up and shaken well in a yard or garden. When this can be done, it should be as frequent as twice a week. In fine weather, bedroom carpets should be occasionally hung out on cords and beaten with small sticks or canes.

1649. *Grease in carpets* may be removed with spirits of turpentine, as well as by fullers' earth, or by soda, ox-gall, and pipe-clay; carpets cleaned by the dyer cost from 6d. to 8d. per yard. (See more on the subject of cleaning carpets in Chap. II., Book XXII.)

SUBSECT. 3.—*Cleaning Grates, Fire-irons, Fenders, &c.*

1650. *Parlour and drawing-room grates*, being of various kinds and forms, require different modes of cleaning. Fire-irons and fenders of polished steel, and such parts of grates as are of the same material, should never, in cleaning them, be touched with any substance that has sufficient roughness to scratch their surface; to preserve their polish, they require nothing but security from moisture, together with the daily rubbing with soft wash leather. Linen is an improper material for rubbing polished steel, as it is apt to be damp. Even the moisture of the hand, if impressed upon steel, is apt to cause spots of rust, if not rubbed off in time with a dry leather.

Once become rusty, steel is scarcely recoverable under the housemaid's hands, nor can the steel polisher entirely restore the even-polished surface. This fact should be impressed on the memory of housemaids, that they may not neglect to apply the leather each day to all the polished steel articles under their charge, and to rub carefully away all dull spots, which are the first indications of rust. The leather kept for this purpose should be frequently aired before the fire, and occasionally a little dried *putty powder* (which may be bought at oil shops), tied in a muslin bag, may be dusted over the steel and then rubbed off with the leather; but, in truth, good rubbing with the leather only is the best means of keeping steel work bright and unspotted.

1651. *When fire-irons* or other fine steel work is not likely to be wanted for some weeks or months, and during which period a housemaid may be away with the family she is serving, it is desirable to rub them over with a little Florence oil; when it is requisite to remove the oil from the steel work, a little dry whiting may be dusted over it, and the whole rubbed clean off with leather. Fire-irons in summer should be tied up in green baize bags, and hung up near the kitchen fire, or in any other office in which there is usually a fire.

1652. *Bright iron bars* of grates necessarily require a different mode of cleaning from that employed for polished steel; they are usually stained with the flame, and browned with the moisture or bitumen from the coal. To remove this, many plans are in use among housemaids; *a good one* is to cover the bars with a little sweet oil, which is suffered to remain on while the housemaid cleans away the cinders from the grate, and with her proper brush sweeps down all lodgments of soot as high up the chimney as her brush will permit. On this point it may sometimes be necessary to remind her, or the family may be inconvenienced by the falling of the soot, if not by the firing of the chimney upon any high flame or sparks flying upward and reaching some of these collections of soot.

This being done, and the grate cleared of ashes and cinders, the oil may be removed, and the bars polished, either by rubbing on them with the leather a little of the smooth white ash formed by the Staffordshire coal, or, where these are not used, by rubbing them either with the Bath brickdust, or with fine emery paper.

1653. *Cast iron grates and fenders* are cleaned with black-lead used in different ways. The housemaid commonly mixes a portion of black-lead with water, of a consistence rather thicker than cream; this, after having cleaned her grate of ashes, she puts on the sides and back of her grate with a small brush, and afterward, when that is dry, with a hard one she rubs the grate with force and briskness until the polish is brought. Black-lead need not be put on the grates more than once, or perhaps twice a week, but each morning the housemaid should brush her grates with the polishing brush.

1654. *Another mode* is to boil a quarter of a pound of best ivory black-lead in a pint of small beer, adding to it a bit of soap about the size of a walnut; this mixture is laid on with a painter's brush, and afterward polished with the hard brush, as above directed.

SUBSECT. 4.—*Cleaning Brass Work.*

1655. *Fenders, if of lackered brass, or any lackered brass ornaments*, admit of very little cleaning beyond that of rubbing with a clean leather; when the lacker is worn off, and they look dull or greenish in appearance, the plates or ornaments may be re-lackered at a trifling expense.

1656. *Fenders with common brass mouldings* may be cleaned, like other brass work in a house, either with oil and rotten-stone rubbed with fine dust of the Bath brick on leather, or polished with polishing paste.

SUBSECT. 5.—*Cleaning Drawing-room Ornaments.*

1657. *Glass lustres* require very careful dusting and rubbing with wash leather; when washed, cold water and soap, applied with soft flannel, is best.

1658. *Ormolu time-pieces*, or other ornamental drawing-room articles, although usually protected from the dust by glass coverings, require occasional dusting, but which should be done with a brush of feathers or silk dusters; the friction of linen, cotton, or any harsh substance, would injure them, as would also any moist application.

1659. *Alabaster figures or vases* can scarcely be cleaned by ordinary servants, and should be, therefore, generally encased in glass, and covered over, as much as possible, with silver paper bags.

1660. *Looking-glasses and mirrors* may be washed with a moist sponge dipped in spirits of wine, no more of the glass being wetted at once than what may be immediately wiped off, as damp, in altering the temperature of the glass, unsettles the backing of the tin coating, which gives it its power of reflecting objects. While wet the glass should be dusted with powdered blue, or whiting tied up in a muslin bag, and then rubbed off with a soft linen duster or silk handkerchief.

1661. *The gilding of pictures and mirror frames*, when it is what is termed *oil gilding*, may be cleaned by washing it gently with soap and water; but if of *burnished gilding*,

which is most usual, it should never have any moisture applied to it. (See Chap. IV., Book V., "Gilding.") A brush of cotton wool or of feathers is best adapted for removing the dust which may settle on it.

1662. *To gilding the flies are the greatest enemies;* but if, during those periods of the year in which they are numerous and active, gilding were covered over with thin coarse leno or gauze, it might be preserved unsoiled for many years.

Sect. III.—Cleaning Articles in the Butler's Pantry.

Subsect. 1.—*China, Earthen-ware, and Glass.*

1663. *China and earthen-ware* should be washed in plenty of warm water and soap, rinsed clean in a second bowl of water alone, either warm or cold, should be then turned down to drain, and afterward wiped dry with linen tea-cloths. Settlings of any liquid which have been suffered to dry up at the bottom of earthen vessels may be dissolved generally by a little pearlash and water, or with soda instead of pearlash; either of these will also quickly remove any oiliness which may be on the surface of earthen-ware or porcelain. Neither porcelain nor earthen-ware will bear sudden immersion into hot water, when the weather is cold, without great danger of its cracking.

1664. *In washing glass* the above caution is still more requisite to observe than in respect to china and earthen-ware.

To put glass suddenly into boiling water in cold weather would be inevitably to break it. Glass should be washed in water moderately warm; and the quantity of water used should be abundant, and in proportion to the number of articles to be washed. When taken out of the water, each article should be at first turned down on a table or dresser, that the water may run off from them. Afterward they should be dried with a soft linen cloth, and, before they are placed for use, each should be polished with a clean soft skin of wash leather kept for the purpose. Glass should never be brought to table with the dull linty surface which negligence in wiping it would give it. *For cut glass,* the use of a soft brush may be requisite to polish it well; but if any brush or rubber of a harsh nature be applied, glass, which easily receives scratches on its surface, would lose irrecoverably its beauty and brilliance.

1665. *Glass discoloured* with the settlings of port wine may require more than common washing. A solution of soda will effect solution of the colouring matter. A bottle brush is sometimes used to remove the wine settlings, but it is liable to scratch the glass.

Subsect. 2.—*Cleaning Plate.*

1666. *Plate* is cleaned in various ways, and every butler or footman has a prejudice in favour of one or other mode. In cleaning plate, the objects to be attained (when it has been washed in hot water and soap immediately after it has been in use) is to erase all scratches and scores which it had received from being thrown carelessly together, or against substances of a harder and rougher nature than its own, and thus restore the polish. After washing it in hot water and soap, it should be rinsed in cold water; then, before putting it away, it should be rubbed with wash leather. But this may not be always sufficient to remove entirely the dim coating given by the oily matters it has been brought into contact with. If greasy, they will require being washed with a hot solution of alkali, such as potash, or soda and water, which will remove the grease and render them fit for polishing.

1667. *For cleaning plate* two good sized skins of wash leather are requisite, together with a brush of soft and fine bristles, for cleaning away from the cruets, ciphers, and chasings the ingredients with which the plate had been cleaned. With one leather, the plate is first rubbed with the powder employed to clean it, and afterward with the other, in order to give it a final polish. As this last-mentioned leather should be kept particularly clean, it should be washed occasionally with soap and water and dried, and used for no other purpose.

1668. *Polishing powders for plate* are sold in the shops; but, as they are apt to wear the silver, they should be used as sparingly as possible. One, called *rouge powder,* is much recommended by silversmiths; and though they find it very useful and effectual, yet, if used as often as plate requires cleaning in a family (perhaps twice a week), the plate would suffer considerable wear.

1669. *Finely-washed whiting is one of the safest plate powders.* To prepare this, mix some whiting up with water, and stir it well; then, letting the whole remain a minute or two, pour off the white fluid into another vessel, and suffer the sediment of the part poured off to settle. This sediment will, when dried, be the fine washed whiting desired, all the coarse gritty part having been left behind in the first vessel. Whiting, in general, is fine enough without being washed; but this operation secures it from containing any particles of sand. It is by some persons applied in its dry state, and rubbed on with the leather. Others mix it with water, and lay it wet on the plate, and do not rub it off till it is dry.

Rotten-stone, mixed with a little Florence oil, is sometimes employed for rubbing away the scratches which plate may accidentally have received; but this must be used with caution.

SUBSECT. 3.—*Cleaning Plated Wares and British Plate*

1670. *Plated wares, and what is called British plate, nickel silver, &c.* (see "Alloys of Metals," in Chap. V., Book V.).—As plated goods consist of inferior metals coated with silver, this coating is easily rubbed off; and hence, in cleaning plated articles, the greatest care is requisite not to wear off the silver coating. All violent rubbing should be avoided, together with the use, in cleaning it, of any ingredient which would wear the silver. When tarnished, plated goods may be cleaned with fine washed whiting mixed with *sweet oil*. Warm water and soap, also, may be safely used.

1671. *Of plated candlesticks, snuffer dishes, salvers, &c.*, the *edges* and *mouldings* are now frequently formed of silver alone. This improvement has occasioned plated articles to be much more durable, as it was at the edges that the plating was first destroyed.

1672. *The sulphur* contained in the sulphuretted hydrogen gas, which exists sometimes in small quantity in the atmospheric air, is constantly acting upon silver, and produces a tarnish. On this account it is very desirable to keep all such articles not in daily use covered with wash leather, or with any soft material, to keep them, as much as possible, from the air.

1673. *Among the careless practices to be condemned* is that of scraping off, with a sharp knife, wax or tallow adhering to plate. If in this practice the surface be scratched, the scratches cannot be removed, except by rubbing off the silver around until it is levelled to the indentations; hence the injury to plated goods especially, in which the silver is merely a thin surface. Another careless mode, and one equally destructive to the articles, is that of exposing the candlesticks to the excessive heat of a fire in order to melt the adhesive wax or tallow. The hollow pillars and pediments of most candlesticks are filled with a composition which gives them weight and steadiness. This composition, with the soldering which unites together the different parts of candlesticks, is melted at the same time that the wax or tallow is dissolved by the fire, and thus the united parts are weakened, if not entirely separated. It is a safer plan to immerse in warm water the sockets and nozzles of candlesticks, and to let them lie until the substances become softened by this slight degree of warmth, when they may be easily removed without injuring the surface of the candlesticks. If this moderate warmth be not sufficient to clear away the wax, a little spirits of wine rubbed on it will loosen it, and allow of its being entirely removed. It must be remembered that very *hot* water will be as prejudicial to candlesticks as a hot fire. It is requisite that the water should not in temperature exceed that which the hand can endure if held in it for a minute or more. After the wax or tallow is entirely cleared away, the candlesticks must be wiped with a duster very dry, and afterward polished with the leather and fine whiting.

1674. *For the cleaning of candlesticks* two leathers and a soft brush are requisite, as well as for the cleaning of the plate used at table. A small skin should be kept for rubbing the articles with the whiting, a larger one for polishing them afterward, and the brush for removing the powder from the mouldings, &c

SUBSECT. 4.—*Papier Machée and Japanned Wares.*

1675. *Tea-boards*, either of *papier machée* or of *japanned iron*, should never be washed with hot water, because the heat of boiling water is sufficient to crack the varnish on the surface, upon which the blackened coating of either the papier or iron will begin to peel off. When any liquid dries upon tea-trays or waiters which has in it something of a glutinous nature, water must be employed to wash it off, but whenever simple rubbing with a soft linen rubber removes any spots on japanned wares, water should not be used. Tea-boards are easily cleaned by the use of a few tea leaves, when emptied out of the tea-pot; if tea-boards of japan or papier machée appear streaky, as if from grease, a little flour or whiting sprinkled over them, and rubbed off with a soft linen duster, will clean them. The fine polish to these wares is in their manufacture given by the use of olive oil, and the friction of the hand alone; hence any scratches on the surface, so slight as not to penetrate through the coating, may be removed by a similar application and means.

1676. *Japanned tea-urns* should, after use, have any warm water remaining in them poured out before it gets cold. The inside should then be wiped perfectly dry with a linen cloth, and the outside be rubbed with a leather kept for the purpose. If any spots caused by the water are rubbed while the urn remains warm after use, they will be soon obliterated then; but if left till the urn be cold, it will be a more difficult matter; they must in such case be removed by the use of the *urn powder*, which is to be purchased either at oil shops or at the shops in which japanned wares are sold.

In cleaning japanned candlesticks, the same caution must be observed as with other japanned wares—that of not employing great heat, either of the fire or of water, in removing from their surface any substance which has adhered to them; with care, these articles may last very long; with carelessness, they are injured immediately. When the coating on their surface is chipped or cracked, they cannot be very long serviceable. Every day's use and cleaning requisite thereon increases the peeling off of the injured surface.

SECT. IV.—CLEANSING KITCHEN UTENSILS OF METAL, ETC.

1677. In country places, where brick ovens used for baking bread are usually heated with wood fuel, the *wood ashes* may be procured, and answer the end of removing the grease from the inside surface of saucepans in which animal substances have been cooked; or a weak solution of potash, boiled in saucepans that require cleansing, will render hard scouring unnecessary, which is sure to wear off the tinning.

In Book V., "On the Materials of Household Furniture," we have shown the nature of *tin plate*, of which saucepans are formed, and the great injury they suffer by being frequently scoured with sand, which wears off the tinning rapidly, exposes the iron foundation, and causes the rust to eat it in holes. When any scouring is requisite, some soft powder should be used, as that of Bath brick and whiting, and sand as little as possible. Saucepans, after being cleaned, should be well dried by the fire before being put

away, and the shelves on which they are put should be in a dry part of the offices. If iron saucepans and kettles remain long in a damp place, they will be spoiled by rust; if copper, by verdigris.

1678. *The corrosion on copper*, called *verdigris*, must be removed, in the first instance, by the application of sulphuric acid (oil of vitriol), and afterward by that of whiting rubbed on with a flannel; copper saucepans tinned should always be carefully examined before they are used. If the tinning of a saucepan be worn away and verdigris formed on the copper beneath, it is unsafe to use it for any purpose whatever, until it has been re-tinned; there having been fatal instances of poison unintentionally given to whole parties at a time, through food cooked in copper vessels from which the tinning had been worn off, and the verdigris formed on the uncovered copper.

1679. *Tea-kettles* should be well rinsed out every morning before they are filled with water. This rinsing is needful to clear away sediment the water in boiling may leave; but the incrustation formed by chemical action within the kettle on every side cannot easily be removed.

1680. The outside of metallic kitchen utensils kitchen-maids pride themselves often on keeping highly polished. That they are bright to look upon is very agreeable, especially as it may be inferred that the inside of the vessels corresponds in cleanliness with that of their exterior. But this pride will be carried too far, if it cause the metal to be worn off with needless rubbing, or retard, by the time it occupies, more important business in the kitchen. The soot adhering to the back and sides of kettles and saucepans ought to be brushed or scraped off, and the fronts, lids, and spouts polished daily; but to polish the whole exterior surface of vessels daily used over smoky fires would be waste of time.

1681. *The outside of copper coal-shuttles* are best cleaned with a polishing paste bought at the oil shops in London, and similar to the composition with which the brass-work on harnesses and carriages is cleaned. The same composition may be easily made of one ounce of spirits of hartshorn, half a pint of vinegar, one ounce of rotten-stone, and one ounce of soft soap. The soap and rotten-stone are to be mixed first together; the vinegar and hartshorn must be afterward added.

1682. *Iron coal hods* may be occasionally done over with a black varnish, which may be purchased at the oil shops, and which will make them last twice as long.

1683. *Steel knives and forks* are cleaned on either ash or deal boards, and sometimes with boards covered with buck leather, as being less likely to wear away the steel of the articles rubbed on them. The leather which covers knife-boards should be prepared by having a coating of mutton fat melted and laid on it with a piece of flannel. The dust of a Flanders brick is then sprinkled over the leather and rubbed well in; and the grease, when a knife is passed over it, ceasing to come through, is the test of the leather being fit for use.

1684. *An uncovered board* should have very little brickdust sprickled over it at once, lest, in rubbing the knives over it, distinct and visible scratches should be given to them. Knife-cleaning is, in fact, done by scratching the surface, but in so fine, regular, and uniform a manner as to brighten the whole surface.

1685. *The height* of the knife-board is another point to be noticed. It should be such as to allow the cleaner to incline his body towards it. Holding a knife in each hand—their backs towards each other—the cleaner should stand in front of the board, and, laying each blade flat upon it, he should bear equally on both, and rub them backward and forward, first on one side and then on the other, until a clean bright surface be restored to each. It is easier to clean two together than one alone. To give a good edge to the knives, the cleaner must scarcely let the blades touch the boards while he expands his arms, but must bear upon them more forcibly in drawing them together again. The edge given by this mode is better than that brought by the steel sharpener.

1686. *Forks* are quickly cleaned by running the prongs several times into a tub filled with a mixture of gravel, brickdust, or sand and hay or moss, kept a little damp and pressed firmly down. When clean, the prongs will require polishing with a thin bit of stick shaped like a knife and covered with leather. Knife-boards are often spoiled by the backs of knives and forks being cleaned upon them. This might be prevented, if a thong of buck leather were nailed at one end of the board, and the loose end held in the hand while the forks were rubbed up and down until perfectly clean and polished. It is also desirable to have a thick square brush nailed to the board, over which both knives and forks are passed, in order to remove the dust partly from them, but which must be more effectually done by the use of the knife-cloth.

1687. *In some houses lathes* are used for cleaning knives, by which, in ten minutes, as many may be done as would in the common way occupy the cleaner for one hour; but the advantage of celerity is counterbalanced by the injury done to the blades, which, in one year, will be as much worn away as knives that had been in use for many years, and cleaned in the usual way.

1688. When knives and forks have been cleaned, either on the board or by the lathe, they must be wiped free from the brickdust with the knife-cloth. The handles of knives and forks require attention, few things being more disagreeable than to feel the handles gritty or greasy.

1689. *Ivory handles* should be washed with a bit of sponge dipped in soap and water, or with a little spirits of wine and water; when a red wine or a fruit stain shows itself on the handles, it may be scraped off with a sharp knife without injuring the haft.

1690. *Silver and plated handles* are cleaned like other plate and plated wares.

1691. *Ebony hafts* should be cleaned with a little Florence oil, carefully wiped off.

1692. Knives and forks always, after being used, should have the blades and prongs dipped in warm water, to wash away whatever may adhere to them; afterward they must be wiped very dry and put into the box to be most thoroughly cleaned on the board.

SECT. V.—CLEANLINESS, A MEANS OF EXEMPTION FROM TROUBLESOME INSECTS.

1693. Cleanliness, undoubtedly, can effect, better than any other means, the destruction of, and freedom from, those insects which nature leads to harbour in houses, and in the vicinity of beds. Such insects, in their first state of existence, are nourished by the dust which collects in the downy fabric of woollen articles especially. In the fur of the cat, and hairy skin of the dog, they also find the warmth and nutriment which brings them to maturity.

SUBSECT. 1.—*Fleas and Bugs.*

1694. *Of the flea*, one of the most annoying of such invaders of domestic comfort, particularly where children are inmates, it has been said that to destroy one in the month of March is to exempt a house of a hundred. The greatest security is that of keeping rooms as free from dust as it is possible.

Carpets, blankets, and everything manufactured from wool, should be so well attended to as to prevent any accumulation of dust from settling in them. The flea seeks to lay its eggs wherever dust and down are combined, for in them consist the nourishment nature has ordained for its offspring.

1695. The blankets used in the cribs and beds of children should, for this reason, be daily shaken, and, weather permitting, hung before an open window, that the air may pass through and clear from dust their loosely-woven fabrics.

1696. The vicinity of dog kennels and pigeon cotes are among the causes of the rapid production of fleas in some houses. Children, in particular, suffer from the inflammation and consequent irritation caused by flea-bites. Hence it should be a particular object to prevent its infesting the nursery. Many recipes for this purpose have been circulated, but none appear to be entirely successful.

1697. *A lump of camphor* left in the ewers whence the water is taken in which children are washed, and in which portions of the camphor are dissolved gradually in the water, it is said, renders the skin washed in it obnoxious to the flea; but this is very doubtful.

1698. *The bug* is chiefly found in large towns. It is a more formidable enemy than the flea, because it evades detection by the most rigid concealment during the day, emerging only at night from its dark lurking-places.

If not infesting the wood-work of old houses, or the cracks of the plaster-work, still it may be brought into our dwellings by many different channels. Sometimes bugs have been introduced between the leaves of old books; in wicker-baskets, which they are said peculiarly to affect; in servants' trunks; and even in the folds of fresh-washed linen from the laundress's house. Hence, in London, how *to prevent* their increase, as well as *to remedy* the evil entirely, is sometimes difficult.

1699. Prevention of the increase both of bug and flea in houses is mainly in the hands of housemaids. Let them carefully practise the cleanly arts of their department, and they will, with more certainty, effect the limitation, even to extermination, of this foe to personal comfort, than by the use of corrosive sublimate, or than that of any other kind of poison. The ground upon which cleanliness proves so effectual in checking the increase of the flea has been shown in a foregoing paragraph. It may be well to point out how similar effects may spring from the same cause.

1700. *As the bug* lives, it is said, only a year, the preventive means should be principally applied to check its amazing increase each year by destroying the eggs. These are deposited, generally, in scarcely-visible cracks and holes in the wood work of bedsteads and skirting-boards. There they might remain until the proper period should arrive for the commencement of their warfare on the human species. The great object of the housemaid must be to displace and wash away these embryo torments, and this, with her *scouring brush* and *cold soap and water*, she may very materially effect. The bristles of her brush will enter where no larger implement could, and detach them from the places where they adhere. If housemaids once in the week during the summer were to scrub with their brushes and cold water all the wood-work of each bed, and to carry the wet mop or scouring flannel under the beds daily and by the skirting-board, the increase of this odious insect would be prevented, especially if the bedding and hangings were also frequently cleared of dust by brushing or shaking them out in the open air.

1701. *Bedsteads much infested* should be taken to pieces twice a year, in the spring and autumn, and the joints and head-board should be well scrubbed with the scrubbing brush. For those who doubt this truth, are subjoined such recipes as have been adopted in some houses, and which for a short time may have checked the evil in them.

1702. 1. *Tar-water* washed over the wood-work of bedsteads. 2. *A solution of potash* also applied to the frame-work of bedsteads. 3. *A paste* composed of Scotch snuff and soft soap, to be inserted within the joints or cracks in the wooden parts of bedsteads. 4. *Bug poison:* spirits of wine, half pint; spirits of turpentine, half pint; crude sal-ammoniac, 1 oz.; corrosive sublimate, 1 oz.; camphor, 1 oz. This mixture should be inserted into the joints of bedsteads with a syringe, and with a sponge fastened to a stick; every other part of the wood-work must be washed with it.

1703. Spirits of turpentine also kills the insects, though it is more volatile, and therefore less preventive and secure than the former recipe.

1704. *Many poisons are to be purchased* at chemists for the destruction of bugs; but it is unpleasant, if not dangerous, to have such mixtures in a house; and with confidence we may assert that they are all far less effectual than the frequent application of the scouring brush and cold soap and water to the bedsteads, and daily searching habits of cleanliness in respect to the other parts of the bed furniture.

1705. We will add the following precautionary hints: *The heads of all bedsteads* should stand a few inches away from the walls. If there be any cracks in the paper behind the bed's head, they should be carefully pasted over with fresh paper; or, if the paper become loose from the wall, that also should be again closed fast. Bugs often harbour in plaster work; but, unless the paper be broken or loose, they cannot find their way through it. If it be suspected that the enemy is secreted under the skirting board, it may be blocked up by pasting, or by glueing strong brown paper over the chink between the skirting-board and the floor.

SUBSECT. 2.—*The Moth.*

1706. *The moth* is a petty, yet formidable enemy in a house. In all woollen manufactures, *blankets*, *flannels*, *moreen curtains*, *carpets*, as well as in furs, and amid feathers, it seeks to form its nest and to deposite its eggs; whence in the spring of the year issue the larvæ which from such substances derive nourishment. In this stage of the insect's existence the ruin takes place of the fabrics upon which it feeds. This is visible in the innumerable small circular holes through which it has eaten, and which, destroying the strength and tenacity of the material, render it worthless.

Many persons suppose that *moths are produced* in clothes that are laid by, merely by their being shut up in closed places; but this is an error. None of the little larvæ or caterpillars of the moth, that really do the mischief, ever appear among clothes or articles of any kind, provided none of the winged moths can have access to them to lay

their eggs there, for no insects can be engendered otherwise than by the usual method of propagation. The moth is an insect that, like all other winged insects, goes through three transformations. *The winged moth*, that flies about in the dark, *does not, cannot eat or destroy cloth of any kind;* but it lays its eggs in woollen articles, upon which alone nature dictates to her that her young must feed. These eggs, in time, produce little *caterpillars*, and it *is they that eat holes in and destroy clothes*, &c. After a time these caterpillars assume the pupa state, out of which burst forth the winged insect, to proceed, as before described, in laying eggs. From this account it is easy to see that, provided you can prevent the winged moth from having access to what you wish to preserve, no injury by moths can happen to them. For instance, if you tie up any article that is quite free from moths in a bag of linen, cotton, or paper, no winged moth can enter the bag to lay its eggs, and therefore the bag will be a perfect security. But it is to be observed, the winged animal is very cunning, or, rather, instinct impels it to search with great care for suitable places to lay its eggs; and therefore simply putting things into drawers, however tight, or covering them over with paper, will not be sufficient; if there are chinks by which the winged animal can insinuate itself, such places will not be safe from moths.

Nature has likewise given the instinct to moths, not to lay their eggs in places liable to be often disturbed; therefore, if you shake any articles very frequently, it is not likely that moths will deposite their eggs there; and if not, there can be no caterpillars to do mischief. These facts being clearly understood, the means of guarding against these destructive insects will be comparatively easy. Should any articles of wool appear to be beginning to be attacked by moths, beating and brushing should be resorted to, and, if possible, they should be put into hot water to destroy the young larvæ. It sometimes happens that, on discovering the *winged moth* in some places, they are driven out to fly about, when they resort to some other part of the house where they will be more safe. This must, if possible, be prevented; otherwise they will continue to propagate somewhere, and the breed will be kept up. Even if driven out of the house, they have been known to enter again at the windows.

1707. *Curtains of moreen or cloth*, when taken from the windows for the summer season, should be well cleansed (by brushing and shaking in the open air) from every particle of dust, and then folded and enclosed in strong unfractured linen, or brown holland wrappers, and laid away in some dry airy room or closet. If the moth have not previously deposited its mischievous embryo, the curtains so enveloped may be considered as safe, without farther notice, for the summer. But if any doubt be entertained on this point, it will be requisite to open the envelopes once or twice during the three or four months of the summer, and to take out and shake well in the open air, if the weather be dry, the curtains or other articles enclosed.

1708. *It is said that the cloth moth* declines as a receptacle for its eggs any spot in which it can detect the odour of the wood of the *cedar*, or of *camphor*, *Russia leather*, *black peppercorns*, and *the tallow of a rush-light*. It is, therefore, very usual to infold woollens and furs with one or other of these supposed specifics. But it is a fact that furriers adopt no other means of saving their stores of furs from the moth than that of frequently shaking each article in the open air and in the sun.

SUBSECT. 3.—*The House Fly.*

1709. *The common house fly* it would be vain to attempt to exclude from our houses entirely. Wherever there are food and warmth, there will they find entrance. The only remedy for the injuries they inflict on clean paint-work and whitewash, or on the cook's bright dish covers, is to wash and clean them as often as the spots become very apparent, and to cover over such articles as do not admit of being so cleansed.

Kitchens are the favourite resort of the common fly. In these a *fly trap*, as it is called, may be used to attract the fly to settle upon it rather than upon the walls or ceiling. Flies seem to incline to settle more on suspended objects than on any other; and thence the use of "the fly trap," which is usually formed of papers of various colours cut out fancifully, in order to render them somewhat ornamental as well as useful.

Fly poison is to be procured from chemists; but there seems little advantage to be derived from its use, as it attracts more flies into a house than it destroys. All are not alike tempted to taste of it. Quassia and sugar, with a little water, set about a kitchen in saucers, is a poison for flies, and not for human beings, and may therefore be safely used.

SUBSECT. 4.—*Mice and Rats.*

1710. *Mice and rats* are animals well known, and against which our best defence is the cat. In the absence of a good mouser, traps are employed, of which various kinds are sold in the shops. As neither mice nor rats can harbour where there are no holes for them to take refuge in, great care should be taken to stop up all such where they are discovered; to a neglect of this may be attributed frequent visits from these animals that might have been avoided. Holes in brickwork should be stopped with Parker's cement. As both mice and rats will gnaw wood, they will often make entrances for themselves into places where provisions are kept; as soon as any of these are discovered the carpenter or bricklayer should be sent for. We object to the employment of poisonous substances for destroying these vermin, on account of the fatal accidents that have been known to result from their incautious use. Rats frequently come from the drains, but the use of proper drain traps prevents this. (See Book I.)

BOOK VII.

ON FOOD.

CHAPTER I.

NUTRITION CONSIDERED PHYSIOLOGICALLY AND CHEMICALLY.

Sect. I.—General Observations.

1711. *The preservation of health depends so much upon a judicious selection of food, as well as on the modes of preparing it*, that we do not consider it necessary to offer any apology for soliciting the attention of our readers to a more than ordinary consideration of this subject. The general diffusion of knowledge, and its application to the ordinary purposes of life, are daily presenting various subjects under points of view hitherto neglected, and we are desirous of treating this branch of domestic economy in a manner commensurate with the advanced state of education. We feel the more anxious on this point, since, although it is one capable of exciting universal interest, yet sound and accurate knowledge of what may be denominated the philosophy of food, has hitherto been limited to a narrow circle, scarcely extending beyond the sphere of medical practitioners.

1712. *It is only by resorting to the sciences of physiology and chemistry* in aid of experience that the subject of food can be successfully investigated. The first makes us acquainted with the anatomical structure of the animal frame, and the nature of those functions upon which nutrition depends. The second teaches what are the component parts of the various substances usually employed as nutriment, and enables us to perceive substantial reasons why one species of food is preferable to another. Unless the subject be viewed in a scientific manner, it is impossible to acquire any other than the most vague notions respecting it, nor to possess the means of distinguishing, among the thousands of opinions afloat, such as have just pretensions to our confidence from those which are founded in error.

1713. *It may be imagined that thus to clothe our subject in a scientific garb* is only to render obscure that which might be made sufficiently intelligible without it. A sort of ridicule has sometimes been attempted to be thrown upon the employment of what are called learned terms in treating of the affairs of common life; and this may be just when they are used unnecessarily, or when they are carried to excess; but it is possible to pursue a medium course; we must have precise and accurate terms to express precise and accurate ideas. In employing such expressions, therefore, as are constantly used by all men of science, we are guilty of no affectation, but are influenced by the same necessity which they feel, not being able to convey our ideas without them. It is not, therefore, the employment of scientific terms that is ridiculous, but the using them when ordinary phrases would do just as well. This fault we shall endeavour to avoid.

1714. *It may likewise be objected*, that it is unreasonable to expect that those who are principally engaged in the preparation of food should, with their limited education, understand scientific descriptions. Our reply to this must be, that we expect no impossibilities; and if our readers were to consist of none but the ordinary operators in the kitchen, we should adopt a different mode. But at present we are supposed to address ourselves to persons of superior intelligence, and whose education qualifies them for comprehending what we have to say; at the same time expressing our conviction that, when the proper means shall be employed, there is nothing in the subject which may not be made intelligible to every ordinary capacity. Let not our readers, therefore, be alarmed at our presenting the various facts which we are desirous of teaching in what they may, perhaps, consider as a formal mode, for they will find that nothing is more simple than the manner in which we propose to explain them, and that to follow us satisfactorily will require only moderate attention.

1715. *We may add farther, that this subject is more important to various classes than is generally imagined.* Those who reside in large cities may be surrounded by plenty of every description, where well-supplied markets offer without any trouble the choice of all that can be produced, in abundance and variety almost perplexing; but it should be considered that many persons may be placed in situations very different, where some knowledge of the principles upon which the nutritious properties of various substances depend may prove highly important. The navigator, in long voyages, has often the opportunity of applying such information to the most valuable uses; and superior science may, with respect to food, as well as in many other cases, prove the safety of a crew. To the soldier and the traveller, likewise, who encounter many hardships, this kind of knowledge comes into play with advantage; and it has been remarked that the success of a battle has sometimes, in a great measure, depended upon a good meal. In short, it is easy to imagine a thousand situations in life where some acquaintance

with the varieties of food, as well as the modes of preparing it, may prove of great utility to individuals who never expected to stand in want of such information. Nor is the subject more unworthy of the political than the domestic economist. A scarcity of food of various descriptions, even in such a country as this, has sometimes occurred; and to possess the means of improving and preserving it, or finding substitutes for articles of such necessity, it is essential to comprehend clearly their actual nature and properties.

SECT. II.—MANNER IN WHICH NUTRITION IS PERFORMED.

1716. *It appears to be a part of the system of our animal economy* that we experience a daily waste in all the various organs, which therefore require to be continually recruited by a supply of fresh materials. Of this waste, and the change that is consequent upon it, we are not, at first, sensible; and few persons are aware of its being so considerable, that perhaps not a single portion of our bodies consists of the same substance that composed it only a few years before. It is to supply this continual decay that nature has given us an instinctive craving for food; and it is the conversion of our aliment into materials calculated to repair the loss which we sustain that constitutes nutrition.

1717. *It is well known that all the substances received into the stomach with this view undergo certain chemical changes*, the whole of which is designated by the term *digestion*, of which we feel it necessary here to give a very brief sketch in order to render our subsequent observations intelligible.

In the first place, then, from the internal surface of the stomach there is secreted a peculiar fluid, called the *gastric juice*, to the action of which all the food which we take is submitted. This liquid differs from every other known fluid, but is said to consist of water, gastric mucus, and hydrochloric acid; it possesses so great a solvent power, that it reduces every species of aliment to a uniform and homogeneous paste, of a grayish colour, called *chyme*, in which the previous texture or nature of the food can no longer be distinguished. The chyme passes into the other digestive organs, where it meets with other secretions, called the *bile*, *pancreatic juice*, &c., by which it is farther altered into a milky-looking fluid named *chyle*. This is taken up by numerous minute vessels, called *lacteals*; and, after undergoing processes which it is not necessary here to follow more minutely, is at last conveyed into the blood, with which it finally unites, and which, circulating through every part of the system, carries the necessary materials for the renovation which we have mentioned.

1718. *Nutrition, then, consists* in the successful conversion of our food, whether animal or vegetable, first into the substance named chyme, then that into chyle, and the farther change of this into blood as the renovator of the system; and the perfection of the several processes by which this is effected depends upon the nature of the food, and the proper action of the digestive organs.

SECT. III.—CHEMICAL PRINCIPLES OF WHICH FOOD CONSISTS.

Having now treated concisely of the physiological part of our subject, we proceed to point out the correspondence between the chemical composition of the only substances fit for food and that of our corporeal frame, in consequence of which the former is enabled ultimately to become a part of ourselves.

1719. *Although the number of different substances which we find in nature* seems almost infinite, yet chemists have shown that the whole of them, whether animal, vegetable, or mineral, are composed of a very limited number of ingredients or principles. The substances which we usually meet with are compounds; and chemistry is an art by which a compound can be separated into the elementary bodies of which it consists. When the vast variety of natural substances are analyzed by the chemist, it is found that they are composed of only fifty-four elementary ingredients, each substance that we meet with containing two, three, four, or more, of these ingredients or principles united together; and since these ingredients cannot, by any known means, be farther separated into other materials, they are called the *simple or elementary substances*.

1720. *Formerly, it was supposed the elements of which all bodies consist were only four*, air, earth, fire, and water—an opinion which is stated in many books still to be met with: but this doctrine is now known to be erroneous; three of them, air, earth, and water, being themselves compounds. We shall not here enumerate all the simple elements; those who are not already acquainted with them may refer to any late work on chemistry. We propose at present to speak only of those which are necessary to our immediate purpose, namely, *carbon*, *oxygen*, *hydrogen*, and *nitrogen*. A few others will be mentioned afterward.

1721. *It is considered that there is no such thing as a conversion, either by nature or art, of any one of these elements into another.* They are, as far as we know, formed originally quite distinct, as gold is from silver or from copper, and, as these may be mixed or alloyed, and separated again, but cannot be changed one into the other, so, in like manner, when there is a compound of carbon, oxygen, and hydrogen, the chemist can

detach these elementary principles from each other, and he can make new compounds by combining them again in different proportions; but he cannot alter the nature of the elements themselves; they are permanent, at least as far as is known, and he cannot change them in the slightest degree. Neither are any of the elements better or worse; they are never known to be imperfect; there cannot be carbon nor oxygen of different qualities; they can appear only to vary from having a slight admixture of other substances. This absolutely invariable nature of the elements it is necessary to keep constantly in mind.

1722. *Now all animal and vegetable substances whatever, including those of our corporeal frame, are composed or made up chiefly of the four elements* which we have enumerated, namely, carbon, oxygen, hydrogen, and nitrogen. They likewise contain a few other elements in very minute quantity, but we may omit the mention of them at present.

1723. *The element called carbon*, though it enters into the composition of every animal and vegetable substance, cannot be presented in a perfectly pure state, insulated or freed from all its combinations, except in the diamond, which is supposed to be elementary carbon crystallized.

Charcoal, the well-known black substance which remains after an animal or vegetable body has been burned, is the nearest to the pure state in which we familiarly see this element. We may here observe, that it is a common expression, "such a substance is burned to a coal, or to a cinder," and the vulgar idea is, that the substance has been *converted into charcoal or cinder* by burning. This, however, is not the fact; there is here no conversion; the carbon of the cinder or charcoal existed in the flesh or vegetable originally, but was so combined with the other principles, that its presence could not be perceived or even suspected, either by colour or any other circumstance. The act of burning has merely driven off into vapour the other elements, the oxygen, hydrogen, and nitrogen; and the charcoal, being less volatile, remains. This fact is quite obvious in the charcoal of wood, in which the organic structure of a branch is distinctly to be traced. The process of burning has, in fact, only effected the separation of the elements from each other; and then the body is said to be *decomposed*. But charcoal is never pure carbon; it always contains a small proportion of other substances; this vegetable charcoal has about 3 per cent., or more, of various earths, together with about 10 per cent. of water and other volatile matter. Animal charcoal, obtained by reducing bones to the substance called *bone black*, contains only 10 per cent. of carbon. The various properties of charcoal will be described when we consider it as fuel.

1724. *Hydrogen*, another of these elements, is best understood by calling it, as it used to be, inflammable air or gas; the gas burned for light consists of this combined with a little carbon. Although hydrogen exists in the solid state, as an ingredient in a great variety of substances, it cannot be detached and exhibited in this state; we can procure it separately in the form of gas only. It is one of the constituents of water.

1725. *Oxygen* exists also in animal and vegetable bodies in a solid state, though neither it, nor hydrogen, nor nitrogen can be separated as solids. Pure oxygen can only be procured, or made to appear in a distinct form, as oxygen gas; this was formerly called *vital air*, because it is that component part of common atmospheric air which alone supports life in respiration; this has been explained in the chapter "On Ventilation." Oxygen is the other constituent of water.

1726. *Nitrogen* is likewise solid in all animal substances, the fleshy fibre, albumen, and the caseine of milk, and also enters, though rarely, into the composition of vegetables. When separate it forms nitrogen gas, one of the components of the atmosphere. Some are of opinion that we may derive a portion of nitrogen from the air which we breathe, as well as from our food. The air of the atmosphere is composed of oxygen and nitrogen.

1727. *We have stated that the elementary principles of which the whole human frame and that of all animals consists* are chiefly those four which we have just described. This being the case, it is obvious that, to repair any loss of substance to which we may be liable, it must be necessary to find some materials composed of the same ingredients or elements as ourselves, and that these alone can constitute food or aliment. Since all animal substances consist of the same elements, though in proportions slightly different, every species of flesh contains the materials for nutriment. The carbon, hydrogen, oxygen, and nitrogen of which they consist may be made to supply any loss of those principles which we daily suffer, by using them as food. In like manner, vegetables may answer the same purpose, because they consist of the same elements, the nitrogen, however, being in much smaller quantity. Thus no substances can ever support life except they contain the elementary principles we have enumerated; and all such, if in an organized state, that is to say, in the condition of animal or vegetable bodies, may compose food under some management or other. Farther, the substance of vegetables and of brute animals are the only bodies in nature, except ourselves, which are composed of these four elements; and thence we see the reason why mineral substances, such as stones and metals, which consist of elements very different, cannot by any means constitute nutriment nor support life.

1728. *From this statement* we easily perceive how important, and, indeed, necessary, is the science of chemistry; since it is by its assistance only that we can determine accurately what class of substances is capable of being converted into nutriment, and what it is impossible we can employ in this manner; and it must be necessary to insist upon the value of that knowledge by which we distinguish, in the most correct manner, the substances *by which alone* life can be sustained.

1729. *It may be said that the experience of ages has apparently rendered this study very little necessary.* Mankind universally understand that animals and plants may supply them with food, and that they cannot extract nourishment from rocks and stones. Nevertheless, it is well known that the arts of civilized life have enabled man to multiply, in an extraordinary degree, the means of subsistence which he possessed in the savage state, when wild fruits, herbs, and roots, the natural produce of the soil, together with the flesh of such animals as were taken in hunting, were his sole support; and we know how scanty and precarious is the supply of these in most parts of the world. Some countries, as Australia, naturally produce few animals, and scarcely any vegetable food fit for the support of life. The result of this uncertainty with regard to the means of subsistence is, that tribes who have no other resource can have no fixed settlement, but roam about in search of some kind of food; among these, under such circumstances, civilization has made no progress, but they remain to-day as they probably were thousands of years ago. It would appear that the first step towards civilized life was the domestication of animals, and the raising of vegetables by cultivation. We all know the advantages which we derive from flocks and herds of cattle; but the astonishing changes and improvement produced in the vegetable kingdom by the ingenuity and industry of man can only be seen by studying the history of our culinary vegetables, many notices of which will be found when we describe the various kinds.

But not only has the gardener and agriculturist contributed largely to the improvement of mankind, by increasing his food, but chemistry has also afforded valuable assistance. Not to dwell upon an infinity of processes by which various alimentary substances have been improved, and are daily improving, through its means, we shall mention some extraordinary instances of the power of chemical science in its present advanced state. From dry bones, formerly considered useless as human food, a large quantity of wholesome aliment is now extracted by a chemical process. But the late discoveries of Braconnot and others are so wonderful that, were they not well authenticated, incredulity respecting them might well be excused. Even common sawdust has, by a very simple process, through the means of sulphuric acid and a little chalk, been converted into a substance closely resembling gum arabic; and this, by another process, has been changed into sugar. In a similar manner, gum and sugar may be made from hemp, flax, and, what is the same thing, linen rags and old ropes. Now, sugar and gum are substances that, to a certain extent, may be employed as food; and thus may dry and otherwise indigestible wood be converted into nutriment. It must be observed that this is not an extraction of sugar and gum from wood, but an actual formation of these substances during the process made use of. This may at first appear to be an extravagant case; but when the reader has studied what we shall have to say respecting the processes of fermentation, he will begin to perceive that these are merely a few of the interesting changes which are the result of natural powers, and which chemistry alone discovers and explains. The fact is, that the substances which we have just mentioned, namely, gum and sugar, are compounds, and consist of the same elements, carbon, hydrogen, and oxygen, though in different proportions; and very slight circumstances are sufficient to bring about such a change in the proportions of the elements necessary to form these different substances as to convert one into another. It is not pretended that science is yet able to turn such curious facts to much practical account, and to extract useful nourishment from every vegetable material; although we may add that sugar is actually manufactured in some places from starch, which is a similar conversion. The instances we have mentioned are rather for the purpose of illustration; but it is evident that by such discoveries a wide field is opened for research, and farther experiments may lead to more important results. Of this, at least, we are certain, that they will make us better acquainted with the nature and properties of the materials which we already possess, and enable us to select, upon principle, those which have the best claim to our preference.

SECT. IV.—ON THE CHEMICAL DIFFERENCE BETWEEN ANIMAL AND VEGETABLE SUBSTANCES, CONSIDERED WITH RELATION TO THEIR USE AS FOOD.

1730. No two classes can offer a stronger contrast than the two great divisions of organic bodies, animals and vegetables. It is well known that the substances of which they are composed have very different properties when employed as food, and it will be interesting to inquire whether chemistry can point out any marked difference in their constituent or elementary principles. We have already stated that both these classes are composed of the same elements, though not in the same proportions. One striking difference between them is, that nitrogen is scarcely ever absent in animal bodies, al-

though it is rare in vegetables; it does occur, however, in certain parts of the latter, as well as largely in the mushroom tribe, and also in wheat; and when this is the case, such vegetables approach somewhat more nearly than the others to the character of animal bodies. Thus, to repeat what we have said, animal substances, in general, consist of carbon, hydrogen, oxygen, and nitrogen; and vegetables consist of carbon, hydrogen, and oxygen, rarely with nitrogen. This simplicity of composition, and both classes being formed nearly of the same elements, is the reason why one class can serve as nutriment for the other upon the principle which we have already explained. Many animals subsist solely upon vegetables, and man is capable of subsisting upon them alone, at least for a time; but he must select such as contain some nitrogen as the most nutritive, to which he adds animal food, which always contains a large proportion.

1731. *Since animal food contains* all the four elements which we have occasion for, nitrogen included, and from this chemical consideration alone, we might suppose that it would afford more powerful nourishment than vegetables, which we know to be the case. In the same manner, likewise, animal bodies, when decomposed, serve, in part, as food for plants, when given in the state of manure. In short, it is easy to perceive that the materials of animals and of vegetables are convertible one into the other by nature, both consisting of the same elements.

1732. This view of the subject is extremely useful, as it will guard us against falling into an error not uncommon. Since we stated above that the elementary principles are absolutely uniform and unchangeable in their nature, there cannot be any which are always of an animal, nor others that are always and necessarily of a vegetable nature; but the same particle of oxygen or hydrogen which one day formed part of a vegetable may, at another period, compose a portion of an animal. We perceive, indeed, through all creation, these different applications of the same matter continually taking place. Vegetables are the food of animals, and, being decomposed into their first or elementary principles by digestion, conduce to their nourishment and growth. Animals, in their turn, either serve as the food of a higher class of animals, or, when they die, contribute, by being decomposed and mixed in the soil, in part, to the support of the vegetable tribe.

1733. *Whether man was intended by nature to feed on animals as well as vegetables* is a question that has frequently been agitated. It has been maintained by some that, in the earliest ages, he lived solely upon vegetables, and that his devouring the flesh of animals was the result of degeneracy. His anatomical structure, however, appears to throw light upon this subject. Carnivorous animals are distinguished from the herbivorous class by their teeth and the organs of digestion: the first are formed in each class in a manner suited to the work they have to go through; and the latter, in such animals as feed solely upon vegetables, are of very great length, as their food requires to be detained longer in the stomach, being more difficult of solution. The omnivorous nature of man appears to be pointed out by his having these organs of a form intermediate between the two classes we have just named. In consequence of this, he enjoys a wider range in the power of extracting nutriment from a great variety of substances. Although he cannot live upon dry wood like many insects, nor digest bones like the hyæna, the great variety which he can subsist upon is eminently calculated for adapting him to different climates, and consequently extending his power to every region of the globe.

1734. *With respect to the effect which these two classes of food*, animal and vegetable, have upon his constitution, it is observed that the first is, in general, the most easily assimilated; that is to say, made to combine with and form part of his frame, which we might expect from the consideration that the elements of which it consists resemble more nearly the composition of his own body. And here we cannot help observing how admirably the productions of the earth are suited to the wants of man in different situations. In warm climates vegetable food is the most abundant, and it is also the most appropriate, since the flesh of animals, in large quantities, would form too stimulating a diet, and too much blood would be formed. On the contrary, in the frozen regions of the north, vegetables are rare, and the inhabitants subsist solely upon animal food, a greater stimulus in cold climates being necessary to keep up the requisite warmth of the body. The Esquimaux have no vegetables whatever, subsisting entirely upon fish and flesh. In temperate climates, a judicious mixture of both appears to be most conducive to general health.

1735. *There cannot be a doubt that the influence of food has been one of those causes that have tended to modify the human race*, and that it must always possess the same power. The strength of the body and the constitution generally must be affected by the nature of the substances by which the vital principle is kept in activity; and it is difficult to calculate upon the degree in which the intellect may depend upon physical causes. Considering the animal part of our nature, the various races of mankind must share, with all other living creatures, in those natural effects produced by climate and food, as well as by the habits and customs which depend more upon himself. All the circumstances respecting our domestic economy are therefore important, not merely as re-

gards what have been denominated our *comforts*; but their effects are felt, and may be traced much more extensively; they bear powerfully upon the general well-being and comparative happiness of society, and act, in no small degree, as moral causes.

1736. *In the description we have given* of the chemical principles of which the substances used as food consist, we have hitherto confined ourselves to those four that are by far the principal ones, and which are never absent in animal and vegetable bodies. But besides these, there are several other elementary principles that are found, if not constantly necessary to the composition of the same substances, yet so generally, though in a very small proportion, that they cannot remain unnoticed.

1737. *Phosphorus* exists in the state of phosphoric acid, which is joined to lime, forming phosphate of lime, in all bones; and Dr. Prout states that the use of a minute portion of phosphorus, discovered by analysis in the yolk of egg, is to supply this element to the bones of the young chick. Phosphorus is likewise found in various parts of animal bodies, and particularly in fish. It occurs also in many vegetables.

1738. *Sulphur* is found in both animals and vegetables, though in minute proportions. It is manifest in the eggs by the blackening of a silver spoon; and the sulphuretted hydrogen, disengaged from putrefying animal matter, proves the original existence of sulphur in them.

1739. *Chlorine* is one of the ingredients of common salt, which is compounded of *chlorine* and *sodium*; both these elements are taken with our food, and it is thought are partly retained, particularly in the blood.

1740. *Potassium*, or the base of potash, must likewise be, in a small degree, a constituent of many animal bodies, and exists in considerable quantity in vegetables, as will be explained in the chapter "On the Laundry."

1741. *Lime*, which is an oxyde of calcium, forms, with phosphorus, the framework of bones, and, for this purpose, must be supplied by our food, in which it exists in very minute quantities.

1742. *Iron.* A minute quantity of this metal, in the state of oxyde, is detected in most animal and vegetable substances upon an accurate analysis; hence it enters into our food.

1743. *Water* is not itself an element, but is composed of hydrogen and oxygen chemically combined. It is essential to all the living functions, and constitutes a large portion of the substance of living bodies, as well as of their food and drink. Water exists in animals and vegetables, not only in its ordinary moist state, but likewise so united to other substances as to lose its usual properties. For instance, sugar and gum consist of carbon united to the elements of water, and yet these are solids from which the water cannot be separated without decomposing the whole; and the same is the case with respect to many other substances. But water in its moist state is necessary to many of the component parts in the animal economy, as the blood, the gastric juice, and all the secretions; water forms, perhaps, the natural drink of all animals, being necessary to supply the waste of this principle. As the blood contains 80 per cent. of water, and the flesh about 75 per cent., it has been calculated that of the entire human body three fourths of its weight consist of water. For the properties of various kinds of water, see Book VIII., Chap. I., "On Water."

CHAPTER II.

OF ANIMAL FOOD.

SECT. I.—GENERAL OBSERVATIONS.

1744. Our object in the following pages will be to give a popular, and, in some degree, a chemical description of all the various substances generally employed in this kingdom as food. As our intention in introducing the reader to the subject of chemistry is at present merely to enable him to *understand clearly* the nature of the several materials which are employed in the culinary art (and which, without *some little* knowledge of chemistry, we contend is impossible), we shall confine ourselves strictly to so much of that science as we consider essentially necessary. Although we do not hesitate to believe that excellent dishes are every day prepared and enjoyed by many persons who have no wish to enter into our subject in the way we propose, yet we cannot doubt that there are also many who are desirous of having a more enlarged view than is usually entertained of the nature of food, and that this species of knowledge will be found not only entertaining, but of real value.

1745. *We shall not here enter into the classification of animals adopted by naturalists.* Those who are desirous of understanding this may consult works on natural history. Our object being solely to treat of such animals as are employed among us for food, we shall only observe that they may be considered as divided into, 1, land quadrupeds; 2, birds; 3, fishes, including the crustaceous inhabitants of the sea; 4, reptiles; 5, insects.

1746. *As a general law, almost all animal substances may be safely eaten*; some are said to be poisonous, but these are confined to a few fish and insect tribes—animals that are among the lowest in the scale of organization. It is not difficult to give substantial reasons for our preference of particular animals as food; yet the accounts of travellers supply us with much curious information respecting the customs of various nations.

Dr. Johnson has remarked, "It is not very easy to fix the principles upon which mankind have agreed to eat some animals and reject others; and as this principle is not evident, it is not uniform. That which is selected as delicate in one country is by its neighbours abhorred as loathsome. The Neapolitans lately refused to eat potatoes in a famine. An Englishman is not easily persuaded to dine on snails with an Italian, on frogs with a Frenchman, or on horse-flesh with a Tartar. The inhabitants of Skye hold not only eels, but pork and bacon, in abhorrence."

From habits, probably, each nation acquires an artificial taste for what they have been accustomed to in early youth, and food the most disagreeable to one becomes delicious to another.

Legislative enactments, also, have prohibited the use of certain quadrupeds as food; and this has been, through prudential motives, not always easy to trace. Thus, pork was

forbidden to the Jews, and in this country we never eat the flesh of the horse; but pork is esteemed by us, while horse-flesh is not only particularly prized by the Tartar nations, but is said not to be despised even by the artificers of a neighbouring kingdom; it is not very palatable, but there is nothing unwholesome in it more than in beef or mutton.

Although the various species of land quadrupeds, and the different parts of them, vary considerably in their flavour and nutritious qualities, yet there is no part of them that may not be safely used as food, and that is not, indeed, occasionally eaten in some parts of the world. The muscles or flesh is, of course, the most important part; but all the rest, the skin, the blood, the fat, and even the entrails, are equally capable of affording wholesome nutriment, where the animals have not been diseased. The bones themselves are not neglected, a considerable portion of them consisting of nutritious matter. With us, the following animals are never eaten, viz., horses, dogs, cats, mice, rats, eagles, vultures, ravens, and some others, yet all of them are used as food in some country or other. In stating these facts, we are not recommending such animals to the palates of our countrymen, our object being merely to explain whether or not they are absolutely unwholesome or injurious. Prejudices, being the result of ignorance, cannot be useful, and their destruction is all we aim at.

Sect. II.—Examination of the various parts of animals with a view to their employment as food.

Subsect. 1.—*General Remarks.*

1747. We do not propose here to enter into a description of the anatomical structure of animals, and we shall consider them as having passed through the operations which render them applicable to the purposes of the culinary art.

1748. *The most obvious practical division of animal substances* which come into the possession of the cook is into, 1, flesh, with the tendons; 2, bone and cartilage; 3, skin; 4, fat of various kinds; 5, blood, to which may be added membrane, brain, shell, horn, hair, and wool. Each of these substances, though belonging to different animals, has certain distinguishing properties by which they are easily recognised and named: thus it is easy to distinguish flesh from bone or fat. At the same time, each of them differs somewhat in the various animals from which they are procured: thus the flesh of the sheep differs from that of the hog, and from beef or the flesh of the ox. Our business, however, at present is not to consider these well-known and obvious distinctions, but to inquire *what is flesh? what is bone?* and *what is fat?* what, in short, is the chemical or actual nature of each of these substances?

1749. *A slight examination will be sufficient to convince us that each of these is not a single substance, but compounded* of several, which are every day separated from each other by the cook without thinking of chemistry or chemical terms. For example, when a piece of meat is boiled, melted fat rises to the surface; when that is skimmed off, and the boiling continued for a length of time till the meat is done to rags, as the cook would say, soup is made; and, if that be concentrated by evaporation by still farther boiling, a jelly will be obtained. The remains of the meat will be a fibrous or stringy mass, almost deprived of fat and juice. Here the meat is separated into fat, jelly, and the fibres of the meat. A similar jelly may also be extracted from bones, but what remains afterward is a hard solid mass, not resolvable into fibres, and very different from meat. If we pursue our examination with respect to all the parts of animals, we shall still obtain fat, the fleshy fibre, jelly, and bony matter not soluble, some parts containing more, and some less, of each of these; and we shall learn to consider all the various parts as made up of the materials we have mentioned, that is to say, that animal substances in general, without regard to the particular parts of the animal, consist of fleshy fibre, fat, jelly, bone, &c. What we have just been doing is, in fact, a separation of animal substances into their component parts; and here we have a division of them much more obvious than that which we considered before, namely, into oxygen, hydrogen, carbon, and nitrogen; the fibre, jelly, fat, &c., being things which we can see and touch, and with which every cook and every person is familiar.

Subsect. 2.—*Proximate Principles.*

1750. *To the well-known substances last mentioned we give the very useful name of the proximate principles of animal bodies*, to distinguish them from those which are termed elementary principles, or elements; and the connexion between these two is this: each of the proximate principles, as, for instance, jelly, is made up, or compounded, of the four elements, carbon, hydrogen, oxygen, and nitrogen, although this fact is not discoverable by any ordinary process of the kitchen. Neither fleshy fibre nor jelly is ever separated by the cook into the elements of which it consists, and for this knowledge we are indebted to the chemist alone. By his art he is enabled to decompose jelly, fleshy fibre, &c., and to say what elements they are composed of. This kind of chemical examination he calls the *analysis* of the substance, and the process he calls *decomposition*, that is, he decomposes jelly, and finds it to consist of the elements oxygen,

hydrogen, carbon, and nitrogen. We are aware that we are now employing terms not in use among those who do not possess a smattering at least of science; but these terms are neither numerous, nor difficult to be understood, and they are coming rapidly into popular use. We trust, however, that the reader will have a little patience with us, and consider what we are saying with attention, and we promise that we will not leave him until the whole has been made as plain as he can desire.

1751. *We will now enumerate the proximate principles of animal bodies under their scientific names.* They are, 1. *Fibrin;* 2. *Gelatin;* 3. *Albumen;* 4. *Oil and Fat;* 5. *Osmazome;* 6. *Casein.* These are the chemical names, which it is best always to employ, without fearing to be considered affected or pedantic. *Fibrin* is the fleshy fibre of meat when it is boiled to rags. *Gelatin* is only another name for animal jelly, but which it is necessary to use for distinction, because there is a very different kind of jelly from fruits. *Albumen* is familiar to every one, being the same thing as white of eggs. *Oil* is well known; and the only stranger is *osmazome,* which we shall describe in its place. Now when we are asked, what is flesh? what is bone? what is skin? we have to consider which of these proximate principles each consists of; and also in what proportions they exist together. We would say, then, that flesh consists of fibrin, gelatin, albumen, oil, and osmazome; in fact, it contains the whole list: but if we are to describe what skin is composed of, we should say that it consists almost wholly of gelatin and fat. We intend this merely as an example, for we shall speak of each of the proximate principles in detail before we proceed farther. Now the reader will no doubt recollect and understand that none of these proximate principles can be simple bodies, because we have several times alluded to their being compounded of our four elements, carbon, xygen, nitrogen, and hydrogen.

1752. *We may farther observe, that the proximate principles of animal bodies are not the same as those of vegetables;* the latter contain no fibrin nor gelatin, but consist of other proximate principles, as gluten, starch, &c. But we propose to treat of animal substances first, and then vegetable substances will follow. Notwithstanding the near approach which vegetable substances make to those of animals in their composition of the simple elements, they differ most essentially in their general properties; and no art can convert the one into the other, nor is it probable that it ever will, because the elements of each have been combined by means of the living principle in a manner of which we have no idea, and which is beyond human means to imitate.

We will now proceed to describe the properties of the proximate principles of animal bodies, and this description must *precede* that of the various parts of animals, namely, flesh, bone, skin, &c., which come into the hands of the cook, because we should not otherwise be understood in describing the nature of these several parts.

1753. *Fibrin.—When a piece of meat is boiled for a long time in water,* the greater part of the soluble part is extracted, and what remains is a stringy matter, which is the fleshy fibre, and is termed *fibrin* by the chemist when obtained quite pure. This forms the basis of the meat, and is the most abundant animal principle. All the red, fleshy part of animals is composed of bundles of these fibres, which are called *muscles.* But by the above-mentioned process, namely, boiling in water, we do not obtain fibrin in a state of perfect purity; for there is still adhering to it a quantity of fat and gelatin. It may be tolerably freed from these by repeated boiling till all the soluble part is extracted. To procure this principle in a state of absolute purity, the flesh must be steeped for fourteen days in cold water, changing the water each day, and squeezing the pieces: if the weather be cold, no putrefaction will take place. After this it must be boiled several times in water, when, at last, it will become quite white, and very little liable to putrefy. When moist, the fibres are somewhat elastic; but when dry, they are brittle, hard, and semi-transparent, like horn. Fibrin is insoluble in spirits, ether, and water, except it be boiled for a long time in the latter, particularly under pressure, and then it is dissolved.

1754. *The red colour of flesh is owing* to the blood dispersed through it in extremely minute veins. When the colour of flesh changes in cooking, it is from the coagulation and change of colour in the blood. When pure fibrin is analyzed, it is found to contain in 100 parts, carbon, 53·36; hydrogen, 7·02; oxygen, 19·68; nitrogen, 19·93.

1755. *Fibrin, when accompanied by gelatin and other principles, as it always is in ordinary boiled meat, is highly nutritive and strengthening;* it is likewise of easy assimilation; but, when deprived of all its gelatin by long boiling, it is rigid, and difficult of solution in the stomach.

1756. *Gelatin.—Gelatin is that part of the meat which, when dissolved and extracted by water, forms a jelly when cold.* Gelatin is found, more or less, in the flesh of all animals, in the form of membranes surrounding the fibres of the muscles, and in bones; the true skin or cutis is composed almost entirely of this principle, the cuticle or scarf skin consisting of albumen. Fine glue may be taken as an example of gelatin. It is procured by dissolving skins by boiling. Pure gelatin or glue, when dry, is colourless, semi-transparent, and nearly tasteless. It is softened by long-continued immersion in cold water: in hot water it readily dissolves, and forms a solution of a slightly milky appearance, which, if sufficiently concentrated, concretes, in cooling, into the colourless mass called

jelly, and which is easily soluble in water; when this is dried in a gentle heat, it regains its original appearance, and is soluble as before. When once dry, gelatin undergoes no change; but, exposed to the air before it is dried, it soon becomes mouldy, and then putrescent.

1757. *Gelatin does not, properly speaking, combine with oils; but it causes oil to mix with water*, and then forms a kind of emulsion. From this we see the reason why a very weak soup will suffer all the fat to come on the top, but a stronger soup will allow the fat to be united with it. From what has been said, it will readily be seen that the strength of meat soups depends upon the gelatin which they contain: they will be strong or weak in proportion as they contain more or less of this principle. Gelatin has a very strong tendency to gelatinize, or become a stiff jelly: if water contain only a hundredth part of gelatin, it will assume the form of a jelly on cooling; therefore water or soup, having a very small quantity of gelatin, may appear a jelly when cold, a circumstance which is very apt to mislead in judging of the quantity of animal matter contained in soup. The water, in this case, is chemically united with the gelatin, forming a compound that may be termed *hydrate of gelatin*. If this jelly, after being solid, be warmed, the water contained in it dissolves the gelatin, and the whole again becomes fluid.

1758. *Gelatin being dispersed more or less through all parts of animals*, jelly may be extracted from them by boiling; but some parts afford a greater quantity of it than others; and it is obvious that those parts are the fittest for making jellies that are composed wholly, or almost so, of this principle. The flesh of young animals abounds more in gelatin than that of old: as animals advance in age, the gelatin disappears and is replaced by albumen. Veal is therefore preferable to beef for broth, as are also parts where there are ligaments, tendons, &c. In calves' feet tho gelatinous matter is abundant: hence calf's-foot jelly. Gelatin is also extracted in large quantity from bones, which consist of this principle, and an insoluble part, which is phosphate of lime.—(See "Bone.")

1759. *Hartshorn jelly* is made from the white part of the stag's horn rasped down and boiled to a jelly. The stag sheds his horns annually about the end of February; when they begin to grow again, they are soft and full of bloodvessels, and are covered with a downy cuticle; but as they increase in size, the blood ceases to flow through the vessels, and the horns become hard and compact. The horns consist of twenty-seven parts of cartilaginous gelatin, the rest being phosphate of lime; so that they resemble bone, and not horns, in general, which consist chiefly of albumen. Hartshorn jelly does not appear to differ from jelly made from other parts of animals. Ivory, which is the tusk of the elephant, is scraped down and used for the same purpose. Several parts of animals yield much gelatin, as calves' feet and heads, cows' heels, sheep's trotters, &c., which are employed in soups and other preparations.

1760. *Portable soups* consist of dried gelatin, and are, in fact, a species of glue made from meat. The gelatin has been dissolved out of meat by boiling, and when dried till it has become hard, it is capable of being preserved, and dissolved again when wanted. The difference, therefore, between portable soup and glue consists merely in the superior quality and cleanness of the animal substances from which the former is prepared. From the insipidity of this principle by itself, portable soups have generally some addition to give flavour. It must be observed, that the jelly we have been considering above is entirely a different substance from the *jelly procured from vegetables*, as currant jelly. In the latter there is no gelatin whatever, and vegetable jellies have not the same nutritive properties as animal jelly. (See "Vegetable Jellies.")

1761. *Isinglass* consists entirely of gelatin, and is the purest variety of this principle: it is a substance prepared from the sounds or swimming-bladders of certain fish, chiefly the sturgeon, which afford the finest kinds. The sounds are cleaned, and the outer coats removed. Like other solid gelatin, it dissolves in boiling water, and becomes a very transparent jelly, that is much used by confectioners for blanc-mange, and other dishes of that kind. The best isinglass is brought from Russia; some of an inferior kind is brought from North and South America, and the East Indies. The several varieties may be had from the wholesale dealers in isinglass in London.

1762. *In choosing isinglass for domestic use*, select that which is whitest, has no unpleasant odour, and which dissolves most readily in water. The inferior kinds are used for fining beer, and similar purposes.

1763. *Jellies were formerly supposed to be particularly nutritive:* at present physicians appear to be of the opinion that they are less so, and even less digestible, than the flesh or muscular parts of animals: still, when acidulated with lemon-juice, and flavoured with wine, they are very proper for some convalescents. In broths and soups gelatin is combined with fat or oil, and it then acquires different properties; but there are various opinions respecting the nutritive and digestible properties of this kind of food.

Gelatin is much disposed to pass into the acid state, and hence it has been supposed to be less completely animalized than the softer parts; for it is one of the characters which distinguish animal from vegetable substances, that the former evolves alkali, and the latter an acid, during their spontaneous decomposition.

1764. *Gelatin is found to contain* from 13 to 7 per cent. of albumen. It yields by chemical analysis, in 100 parts, carbon, 47·881; hydrogen, 7·914; oxygen, 27·207; nitrogen, 16·998.

1765. *A solid gelatin for dietetical use*, in thin plates and strings, has lately appeared in the shops, to be used instead of isinglass, on account of its inferior price. The best is transparent, and is brought from France; it is prepared from the gelatin of bones, by digestion in diluted hydrochloric acid, and long boiling in water. Another kind, called Nelson's patent opaque gelatin, is prepared from cuttings of skins, and is therefore a

kind of glue. None of these are equal to isinglass in nutritive power and digestibility, properties which, it has been shown, are diminished by long decoction; and the sources from which they are procured are not calculated to recommend them.

1766. *Albumen.—This principle enters into the composition of many of the solid parts, and more largely than any of the other principles into the fluid parts, of animals.* White of eggs is nearly pure albumen with four fifths of water, and may serve to illustrate its properties. This can be beat up with cold water, making *glaire of eggs*, which will dry, if laid on thin, into a hard, transparent substance; but if white of eggs be put into water nearly boiling, it will, as every one knows, coagulate or *set*, as it is called, into a pearl-white substance. In the living animal there is a solid albumen as well as liquid. Liquid albumen exists in great quantity in the serum of blood, where it is held in solution by water, and it may be obtained in an uncoagulated state, like glaire of eggs, by evaporating the clear serum by a heat of 120°. A solid albumen is found in several of the membranes, cartilages, skin, glands, and vessels.

1767. *Though albumen naturally exists as an adhesive fluid, mixible with, and soluble in, water, either cold or warm, yet, when subjected to a temperature of about* 142°, *it experiences a remarkable change in its properties*; it is then converted into a solid no longer capable of being dissolved in water; and if, after coagulation, it be gradually exposed to a higher degree of temperature, it is reduced to a firm, transparent body. When solid, it approaches nearly to the nature of fibrin, and it acquires some flavour by coagulation, for in its liquid state it has little or none. Albuminous liquids have always a little free soda, and the white of egg contains also a small quantity of sulphur, the latter of which is the cause of its blackening a silver spoon. Dr. Bostock has shown that when one part of dry albumen is dissolved in nine parts of water, the solution coagulates by heat, and becomes solid; but if the albumen amount only to $\frac{1}{15}$ of the liquid, though it coagulates in some degree, yet it does not do so completely, but the liquid may be poured from one vessel to another. When one part of albumen is dissolved in 1000 parts of water, the solution becomes cloudy when heated. Uncoagulated albumen soon putrefies, except it be dried; but it keeps longer when coagulated; hence cooked meat and eggs keep longer than when raw. The presence of albumen in a solution, though not in quantity sufficient to coagulate by heat, may be ascertained by putting in a drop of the saturated solution of corrosive sublimate: if the water contain only $\frac{1}{2000}$ part of albumen, a cloudiness will appear. It can form a soap with alkali.

1768. *Fluids are often clarified by means of albumen*, through its property of coagulation. When any kind of it, as white of eggs, or the serum of blood, is put into a liquid that is muddy from substances suspended in it, on boiling the liquid the albumen coagulates in a flocculent manner, and, entangling with it the impurities, rises with them to the surface as a scum, or sinks to the bottom, according to their weight.

1769. *Albumen, when analyzed*, is found to contain in 100 parts, carbon, 50·00; hydrogen, 7·78; oxygen, 26·67; nitrogen, 15·55.

1770. *Animal Oil.—Under this head is included every species of fatty matter in animals*; and it exists in a state more or less fluid, or approaching to solidity, in various animals, and in various parts of their bodies. Some varieties, as suet, have considerable solidity, and others, as fish oil, are mostly in a liquid state. Carbon and hydrogen, with a very little oxygen, form the elements of pure oil, without any nitrogen, in which this differs from the rest of the animal principles. Indeed, from analysis, it appears that animal oil is very analagous to the fixed vegetable oils, both in composition and properties. The nature of the various animal oils has been more particularly considered when treating of "Artificial Light." See, also, "Fat," Subsect. 8.

1771. *Osmazome.—This substance is procured from an extract of meat*; it was discovered by Thouvenet, and is supposed to be the principle that gives the peculiar flavour to meat when roasted, or in soups. Berzelius, however, does not admit it to be a distinct principle, and thinks that it is formed during the culinary process. When procured separate and pure, it has a brownish-yellow colour, with the taste and odour of soup. It is most abundantly developed in the outside of roasted meat.

1772. *Casein.—Casein abounds in the curd of milk* coagulated by means of rennet, of which cheese is made. It is very analagous to albumen, although now considered as a separate proximate principle. (See "Milk.") Casein is very easy of digestion, and is very nutritive.

Having now described those proximate principles into which all the parts of animals are resolvable without final decomposition taking place, we proceed to state which of these principles, and in what proportion, the *various parts of animals* are composed of.

SUBSECT. 3.—*Skin.*

1773. All animals have an exterior covering to protect them from the surrounding elements, as well as to perform other functions. In the lowest classes this covering is frequently hard and crustaceous; but in the higher classes, it is usually soft and pliable. In man, as well as in the ordinary quadrupeds used among us as food, it is composed of two parts: a thin elastic layer on the outside, called the *epidermis*, or cuticle, and a much thicker layer beneath, called the *cutis*, or *true skin*.

1774. *The cuticle* is that part which is raised in blisters, and is easily separated from the cutis by maceration in hot water. It is insoluble in cold water, and is considered to be a modification of albumen. It has little tenacity, and is destitute of blood-vessels, nerves, and fibres; consequently, has no sensibility. It is dissolved by alkalies and lime. In some of the inferior classes of animals it consists of scales or plates, and in others it is extremely soft and smooth, almost resembling mucus.

1775. *The cutis or true skin*, in quadrupeds, is a thick, dense membrane, composed of fibres closely interwoven, and disposed in different directions like the texture of a hat; the interstices being filled up with gelatin, of which the principal part consists. It is obviously organized, and is filled with innumerable blood-vessels and nerves, which occasion its extreme sensibility when cut.

Common glue is made by boiling skins, in which process the gelatinous part is extracted. Those skins that are the most flexible, as that of the eel, dissolve the most readily, and afford the greatest quantity of gelatin, but make the weakest glue.

Size is a preparation made by boiling skin to a jelly.

Leather is likewise formed from skin, but it is by combining the gelatin which it contains with the tannin in bark, the result being a peculiar substance which is no longer soluble in water, cold or hot; and this constitutes the process of tanning. See "Gelatin."

SUBSECT. 4.—*Cellular Membrane.*

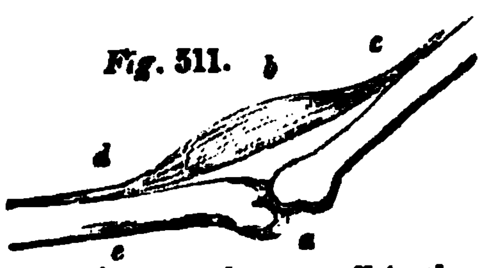
1776. *This is a very soft, spongy substance that lies between the skin and the flesh; and a similar material is dispersed* through every part of the body, frequently entering into their substance, connecting the several parts with each other, and preserving them in their proper places. It is composed of numerous minute cells formed by a very thin membrane, which are filled with a fatty matter, that varies in quantity according to the species of animal, and the condition of the individual. It is the proper receptacle of the fat. In some animals, as the ruminating quadrupeds, it is only partial; but in others, as the hog and the whale, it extends, with its fat, under the whole of the skin: the membrane itself consists partly of albumen and partly gelatin, and is not soluble in water.

SUBSECT. 5.—*Flesh.*

1777. *The flesh of animals, and which is the principal part employed as food, consists* entirely of the various muscles, the use of which is to enable them to move and to perform their several functions. Each muscle is composed of a bundle of those minute fibres, which we mentioned when speaking of fibrin. It is bound together, or united at each end or extremity, where the fibres compose a firm, close texture of a silvery colour, and possessed of great tenacity. These terminations, which differ altogether in appearance from the muscle itself, are called *tendons* or sinews. If the muscles be examined with care, it will be seen that each bundle of fibres is enclosed in a very fine membrane, and they are often divided interiorily by other membranes into smaller bundles; also, that the tendons are semi-transparent, very elastic, and strong, being securely fixed to the bones.

1778. Although it is not absolutely necessary to our subject, still it will illustrate the nature of muscle to show its proper use in the animal frame, which is, to perform the various motions of the body. The manner in which these motions are effected is the following: The bones form what is called the skeleton, and there are joints where it is necessary we should move certain parts at our will. Let *a* be the elbow joint, which is to be bent; a muscle, *b*, or, as we have said, a bundle of fibres, is bound together or united at each end into a tough substance, called a tendon, *c* and *d*, and these are fixed, one to each bone of the arm, above and below the elbow. Now, when we wish to move our arm, we can, merely by our will, through means incomprehensible to us, cause this muscle to swell in the middle, and, consequently, to contract in its length; the consequence of this shortening of the muscle from *d* to *c* is, that the bone, *e a*, is raised upward, and the arm, of course, is bent. In the same manner all the motions of our bodies are performed; one end of a muscle is fixed to one bone, and the other end to another bone, and our will causes the muscle to swell in the middle, or *belly* of the muscle, as it is called, and thus give rise to motion.

Fig. 511.



1779. *The fibrous structure of flesh is best seen in meat that is dressed, but particularly in boiled meat*, as veal or leg of beef. The nature of a muscle is easily perceived in cutting up the leg of a fowl that is sufficiently entire; for, when meat is cut for sale, the muscles are usually divided across, so that portions of them only are visible in one piece. The fibres constitute what is usually called the *grain* of the meat; thus, we speak of cutting across the grain when we divide the fibres across. The quality of meat is judged of, in some measure, by the coarseness or fineness of these fibres: in very large animals, as the elephant, rhinoceros, &c., they are very coarse and unpalatable; on the contrary, the fibres of the flesh of very small animals, as the mouse, are very small, and the flesh is very delicate, and, although not eaten in this country, was highly prized by the luxurious inhabitants of ancient Rome, who fed them for the purpose. It is a curious fact, that the actual fibres of flesh are so minute that the smallest one visible to the eye is composed of many others still smaller, laid close together.

1780. *In the muscles is intermingled a small quantity of fat and gelatin*, the proportions

of which is different in those of different animals, and in different parts of the same animal, or according to their condition. *Thus, flesh consists* chiefly of fibrin, or the pure fibre, which, as we have stated above, is of itself white, together with some blood, gelatin, a small portion of albumen, and a large quantity of water. There is likewise a minute portion of salts, as will be seen by the analysis. By boiling, the gelatin is dissolved, the albumen sets and hardens, a very small portion of the fibrin is also dissolved, but the greater part remains in the fibrous form.

1781. *Berzelius made a careful analysis of lean flesh:* about three fourths consisted of liquids. The following were the constituents which he obtained: in 100 parts, fibrin, vessels, and nerves, 15·8; muriate and lactate of soda, 1·80; albumen and colouring matter of the blood, 2·20; phosphate of soda, 0·90; extractive matter, 0·15; albumen holding in solution phosphate of lime, 0·08; water and loss, 77·17. From this analysis we perceive that the greater part of a portion of flesh consists of water, and that there is not an ounce in a pound of solid matter that can be assimilated; but this ounce, it may be supposed, is extremely nutritive.

1782. *The solution of the gelatin of flesh forms soup by boiling*, and, from its presence, liquid soup is liable to become sour in keeping, acetous acid being formed.

1783. *The flesh of various animals, as is well known, differs in flavour*, and, in a slight degree, in composition. The quantity of blood in it augments with the age of the animal; and the flesh of young animals contains more gelatin than of old: that of the same species varies, as has been observed previously, by the circumstances of sex, feeding, age, &c. The digestibility is likewise much affected by the modes of cooking.

1784. *The muscular fibre is likewise possessed of a property called contractility*, that is, it has always a tendency to contract in length. This is shown when a muscle is divided across during the life of the animal, or soon after it is dead; for the wound opens very wide, from the contraction of the part on each side, and this is the basis of the operation called *crimping* in fish, which is cutting across to cause the fibres to shrink and become firmer. The state of the fibre after death is also influenced by the manner in which the animal has been killed. If it be killed suddenly while in full health, the muscles are firm and contracted, and they remain a long time rigid without undergoing putrefaction; whereas, on the contrary, if death ensue after violent exercise, the muscles are relaxed and soft, have lost all their contractility, and much sooner become putrid. This is the origin of the barbarous practice of baiting cattle previous to slaughtering them, in order to make the flesh tender.

1785. *The liability of flesh to become putrid, Hatchett supposes, is chiefly owing to the gelatin;* for, when this is removed, the remainder of the fibres, if dried, is not liable to putrefy. When flesh is submitted to combustion by fire, all the proximate principles are decomposed, and the elementary principles are dissipated, except perhaps the carbon, which remains in the form of a black cinder.

1786. *Tendons* consist chiefly of gelatin with a little albumen; consequently they dissolve partly in long boiling.

Subsect. 6.—*Bone.*

1787. *Bones compose the solid framework of the body:* they are the fixed joints against which the muscles act to produce motion. When a bone is divided longitudinally, so as to disclose its internal structure, we observe that the external part is the most compact, and the interior more cellular or spongy. The proportion of the compact to the cellular part depends upon the particular bone and the species of animal, as likewise upon its age, the bones of young animals being softer, and those of older animals becoming more dense. Certain parts of bones also are hollow, or filled up only by a very open texture consisting of minute fibres crossing like network. In the cavities of bones the marrow is contained, and all through the spongy or cellular substance there is dispersed more or less of an oily matter, very analogous to marrow, but more fluid.

1788. *When bones are examined chemically* they are found to consist chiefly of an earthy base, called phosphate of lime, which is lime and phosphoric acid. Of this material, together with cartilage, the skeleton of the bone is composed; and the numerous minute cells and interstices are filled up with gelatin and the oily matter above mentioned.

1789. *The structure of bone and the existence of the phosphate of lime may be easily shown.* If a bone be burned in the fire, it will generally, at first, flame and become black in the same manner as flesh; this arises from the combustion of the oily matter contained in the cavities or cancelli of the bone; and as the hydrogen of the oil is the element that affords the flame, when that is dissipated, much of the carbon is left, which gives the black colour to half-burned bones; but, by a continuance of the heat, the carbon likewise flies off, and the bone will become red hot; in this state it consists only of phosphate of lime, deprived of all animal cement. When the bone cools it will be of a white colour, and then the internal structure may be easily observed by breaking it across and viewing it through a magnifying glass. This white substance, when ground to powder, is called bone-ash, and is used for various purposes; among others, polishing, under the name of burned hartshorn.

1790. *When bones are broken to pieces and boiled* for a considerable time in water, the gelatin and oily matter are extracted, the latter rising to the surface as fat, leaving

only the cartilage with the earthy matter, which are not soluble in water, or scarcely so; and every cook knows how to procure a certain portion of gravy by this means. The extraction of the soluble part is much promoted by rasping the bones, since thus all the cells in which it is contained are laid open; while the bones are only broken in pieces the greater part of the gelatin remains still locked up in the hard substance of the bone. A method of extracting the whole of the gelatin for the purpose of soup will be shown when treating of "Soup from Bones."

1791. *The bones of cattle slaughtered in London were formerly of such vast accumulation*, that it became necessary to consume them from time to time. This process was reserved for some holyday, or period of public rejoicing, when fagots and combustible materials were collected for the purpose of illumination. At present, bones are applied to a variety of purposes. They are useful to mechanics when ivory would be too expensive; they are essential in the formation of sal-ammoniac and phosphorus; produce an oil much used by coach and harness makers, called neat's foot oil, and, when ground to powder, form a valuable manure, &c. Since bones with us can be so profitably employed, perhaps it is not desirable to imitate our continental neighbours in making soup from them, particularly as this is not a favourite food in England.

Subsect. 7.—*Cartilage.*

The ends of the bones at the joints are capped by a smooth white substance, somewhat softer than themselves, upon which they move and turn; this is cartilage. It is the first part of the bone which is formed in the fœtus state of the animal, and the earthy part begins afterward to be deposited when the animal comes into the world and obtains food. Cartilage consists of coagulated albumen, with a very little gelatin, and therefore is not soluble in boiling water, except by long-continued boiling under pressure. In very young animals the bones are almost all cartilage, the elasticity of which is the reason that they are so little hurt by a fall: as animals advance in age, the bones become harder and more brittle, having more albumen and earthy matter, and less of gelatin. In some fishes, as in the skate, the bones are entirely cartilaginous.

1792. *Teeth* consist of the same material as bone, except the enamel on the exterior, which is phosphate of lime and carbonate of lime, in the proportion of 78 parts of the former and 6 of the latter.

1793. *Ivory* is nearly the same as bone, with a large proportion of gelatin.

1794. *Horn* differs from bone in containing scarcely any phosphate of lime, being composed almost entirely of coagulated albumen with a very little gelatin; they are therefore not much different from cartilage. Horns soften by heat, so as to be moulded into any form, but do not dissolve in boiling water. The horns of some animals, as those of the ox, are hollow, and have the central cavity filled up by a bony part called the *core*. The horn of the stag, however, is a remarkable exception; it differs entirely from the horns of the ox or sheep, being more analogous to bone, and consisting of much gelatin, with some phosphate of lime; hence, as was observed before, it is soluble in water, and from it is made *hartshorn jelly*.

1795. *Hoofs*, *nails*, *feathers*, *hair*, and *wool* are very similar to horn in their composition.

Subsect. 8.—*Fat.*

1796. *Fat is an animal oil of various degrees of consistency, according to the kind of animal, or the particular part of the body* in which it is situated. It is contained in the minute cells of the cellular tissue or texture above mentioned, and is chiefly collected between the skin and the muscles, or in the interstices between the muscles, or round the viscera. While the fat remains in the living body it is always in a fluid state, or semifluid; but its consistence changes when it is extracted and exposed to the common temperature of the atmosphere. When examined by a powerful microscope, this fat or animal oil is seen to be contained in extremely minute hollow cases, which are of different shapes, spherical, or even polygonal, according to the animal, as in man, oxen, sheep, and other quadrupeds. The case itself resembles the nature of spermaceti.

1797. *Of the varieties of fat in quadrupeds, suet is the firmest;* the next in hardness is the fat of bones, and the next to that the fat in the muscles. The fat of the hog is the least solid. The fat of birds has little solidity, and in many species it is always fluid: this is usually distinguished by the term *grease*, as goose grease. The fat of fish is always in oil or fluid, except spermaceti.

1798. *Suet* is the fat which invests the kidneys of oxen or sheep. The internal fat of all ruminating animals is harder than that of others, and is slightly brittle; when melted and separated from the membranes in which it is contained it constitutes *tallow*.

1799. *Lard* is the fat of the hog separated in the same manner. It differs from suet little but in being of a softer consistence. Its use to the cook is well known. The hog's lard that is sold in bladders is prepared by chopping the raw lard fine, or, rather, rolling it out to break the cells in which the fat is lodged, and then melting the fat by a water-bath or other gentle heat, and straining it warm into bladders; or by melting the raw lard in water, and skimming it off when cold; but by the latter process a quantity of water is always contained in it, and this kind of lard grows sooner rank than when melted by itself.

1800. *To obtain animal fat, in general, in a pure state*, it is to be melted and strained

from the investing membranes, and a little water is added, while melting, to prevent its being scorched. When thoroughly purified, it is white, inodorous, and tasteless, while quite fresh, and is then very analogous to fixed vegetable oil (see Sect. 10, Chap. VII., Book VII.); it, however, becomes sooner rancid than the latter, if exposed to the air: a change which is owing to an absorption of oxygen, and the consequent formation of an acid, which is named the *sebacic acid*, or acid of fat. If this acid is abstracted by washing by means of water, the sweetness of the fat may be sometimes restored.

1801. *Different kinds of fat liquefy at different temperatures:* lard melts at 97°; tallow requires a heat somewhat greater; but the fat extracted from suet by boiling requires 127° to liquefy it. The great inflammability, and the bright white light it gives while burning, renders the most solid kind, tallow, eminently serviceable for producing artificial light. Tallow itself will not inflame: it is only the vapour of tallow that inflames; and it does not boil till it is heated to 400°. Fat acts upon some metals; thus, if copper be covered with it, the surface soon becomes green, and a poison is formed.

1802. *It is now known that fat is not to be regarded as a simple principle*, but as consisting of two distinct principles, which may be separated from each other, a fact which we stated before, when treating on "Candles." One, called *stearin*, is always solid at the ordinary temperature, and melts at 100°; when pure it is white, brittle, and without taste or smell: the other, an oily substance, more fusible, is called *elain*, and is always fluid at the common temperature, becoming solid at 45°: it is generally of a yellow colour.

1803. These two principles, *elain* and *stearin*, exist in very different proportions in various fatty substances, as will appear from the following table:

	Elain.	Stearin.		Elain.	Stearin.
Butter made in summer .	. 60	40	Goose fat	. 68	32
Ditto, in winter . . .	. 37	63	Duck's fat	. 72	28
Hogs' lard	. 62	38	Turkey's fat	. 74	26
Beef marrow	. 24	76	Olive oil	. 72	28
Mutton marrow . . .	. 74	26	Almond oil	. 76	24

The stearin and elain seem to be mechanically mixed in animal fats, for they can be obtained in a separate state merely by squeezing tallow between folds of blotting paper: the elain is absorbed by the paper, and the stearin remains by itself as a solid. To procure the elain by itself, the paper which has absorbed it must be soaked in warm water, and the oil will swim upon the top. It is the elain which gives the peculiar smell to the various fatty substances, and tallow deprived of it is both more solid and white, without any smell. This discovery has been applied to the improvement of candles. They may also be separated from each other by means of alcohol. If fat oil be boiled in alcohol the stearin crystallizes as the spirit cools, and the elain remains in the solution. See farther under "Soap."

1804. *Marrow* differs from other fat only in the fineness of the membranous texture in which it is contained, the fluidity of the oil, and its situation within the bones.

1805. *Fat, as well as all fixed oils, is difficult of digestion*, particularly by weak stomachs, and therefore is not proper for dyspeptics. It is apt to cause bile in the stomach. But fat is rendered still less digestible when subject to high temperatures in some culinary processes, as in frying. All meats and fish that contain much oil or fat are apt "to lie heavy at the stomach," as it is called, or, in other words, to be difficult of digestion; and then they are apt to occasion heartburn and other injurious effects. It is thought, however, that bacon and salt pork are more easily digested than fresh fat.

Subsect. 9.—*Blood.*

1806. *Blood consists of two parts: the coagulum, clot, or crassamentum*, and the *serum*. It is well known that blood, soon after it is drawn, separates into these spontaneously. The coagulum is the part which becomes solid, and contains the red colour; it consists of exceedingly minute coloured globules, to be seen only by a good microscope; these float in a transparent fluid. The red globules themselves consist of fibrin and albumen, according to Berzelius, and the colourless serum consists of albumen dissolved in a saline fluid. The coagulum of blood is very analogous to flesh, and seems to possess equal nutritive properties. The serum is very analogous to the white of egg, and, like it, coagulates by heat. It contains no gelatin. The red colour of the globules appears to be owing to a peculiar colouring matter; and it may be removed by washing the coagulum repeatedly in water: the coagulum will then appear of a whitish colour, being pure fibrin. The blood of animals is used as food, and is very digestible and wholesome; that of the hog and of the ox is used for making black puddings; as likewise that of the goose in some places.

Subsect. 10.—*Mucus.*

1807. *Mucus is a substance generally liquid*, and which appears to be employed by nature for the purpose of lubricating moveable parts, or of protecting them from the action of other substances. It has a resemblance to gelatin, but is distinguished from it by being soluble in cold water, and not gelatinizing or becoming jelly; nor is it coagulable by heat, like albumen. Mucus is coagulated by subacetate of lead, which does not af-

fect gelatin. It is in too small quantity to be considered as very important in the subject of food.

SUBSECT. 11.—*Shell.*

1808. *Shells of eggs, of oysters, muscles, periwinkles, and other animals of the molluscous class, differ from bone in consisting* of carbonate of lime, or the same substances as chalk, with a little animal matter: when they are burned in the fire they give a very pure quicklime. A few shells contain also a little phosphate of lime.

The crustaceous coverings of crabs, lobsters, &c., consist of phosphate of lime and carbonate of lime, with a little animal matter.

SUBSECT. 12.—*Internal Organs.*

1809. *The various internal organs, as the heart, lungs, usually called lights, liver, sweetbread, kidneys, &c., consist* of fibrin, gelatin, albumen, &c., in different proportions, according to the particular organs, which, intermixed with blood-vessels and nerves, are too various to describe in detail. The heart, liver, and kidneys are not of such easy digestion as meat in general; but the sweetbread is a favourite dish for convalescents. Few things are so readily digested as *tripe*, which is the stomach of ruminating animals, as the cow.

1810. *It is proper to mention that eminent physicians have stated* it as a well-known fact that "the bodies of animals who are diseased are capable of communicating fatal diseases to the human species;" and Dr. Paris observes, that "experience has shown that such animal poison is particularly energetic in those parts that are commonly called the *offals*, in which term are included the *intestines*." To account for the deleterious changes of which those parts appear to be occasionally susceptible, it is not in the least necessary to suppose that the animal died in a state of disease. We are informed by Dr. Kerner of Wurtemburg that the smoked sausages, which constitute so favourite a repast in his country, often cause fatal poisoning. In one instance thirty-seven persons died out of seventy-six who had eaten them; and, though the most able chemists analyzed the meats, no trace of any known poison could be discovered. The following details respecting this remarkable fact are from Professor Graham's work on "Chemistry:" "In Wurtemburg the sausages are prepared from very various materials. Blood, liver, bacon, brains, milk, bread, and meal, are mixed together with salt and spices; the mixture is then put into bladders or intestines, and, after being boiled, is smoked. When these sausages are well prepared, they may be preserved for months, and furnish a nourishing savoury food; but when the spices and salt are deficient, and particularly when they are smoked too late, or not sufficiently, they undergo a peculiar kind of putrefaction, which begins at the centre of the sausage. Without any appreciable escape of gas taking place, they become paler in colour, and more soft and greasy in those parts which have undergone putrefaction, and they are found to contain free lactic acid or lactate of ammonia—products which are universally formed during the putrefaction of animal and vegetable matters. The death which is the consequence of poisoning by putrefied sausages succeeds very lingering and remarkable symptoms. There is a gradual wasting of muscular fibre, and of all the constituents of the body similarly composed. Sausages, in the state here described, exercise an action upon the organism, in consequence of the stomach and other parts with which they come in contact not having the power to arrest their decomposition; and entering the blood in some way or other, while still possessing their whole power, they impart their peculiar action to the constituents of that fluid." Similar effects have occurred in Paris; and it has been conjectured that animal matter in peculiar states of disease or decomposition may constitute an *actual poison*, hitherto not understood, and only evinced by casual effects. Sir Benjamin Brodie has remarked that, on several occasions, he has met with evidence of the acrid and poisonous nature of "dog's meat," as sold in the streets of London, which manifested itself by producing ulcerations of a peculiar and distinct character on the hands, accompanied by swellings in the axilla.

SECT. III.—ANIMALS USED FOR FOOD CONSIDERED AS INFLUENCED BY SIZE, AGE, SEX, SEASON, MODES OF FEEDING, ETC.

1811. *Size.*—As a general rule, the flesh of the largest animals is, as might be expected, of a large fibre, or, as it is called, *coarser in the grain*, and less palatable than that of smaller animals. The flesh of the elephant and rhinoceros has been found to be very coarse, but we know little of their properties, being scarcely known as food. Even the larger kind of oxen affords coarser beef than the smaller breeds. Mutton is more delicate, in general, than beef; and, descending to much smaller animals, mice are said to be particularly good eating. The same observation will apply to birds and fish; the larger, in general, being the coarsest food, and the smaller more delicate and tender; but it does not appear that the nutritive qualities are in proportion to the fineness of the fibre and the delicacy of the meat.

1812. *Age.*—In general the young animals of any species are more gelatinous than the older of the same species; hence their flesh is more soluble, and yields more to the action

of boiling water; boils more tender, and is more nutritive to weak stomachs than that of older animals; but as they increase in age, the gelatin gradually diminishes; they contain more fibrin, albumen, and osmazome; hence the flesh affords a stronger food, and has more flavour, until age again destroys these qualities, and renders it stringy, dry, and indigestible. By the increase of albumen the membranes become more solid, and motion more difficult; and, at last, sometimes the ossification of those parts takes place. But though the flesh of young and old animals varies considerably in its properties, some being too soft and flabby, and others too tough, yet at no period of life is it absolutely unwholesome, provided the animals are in a healthy state. Calves and lambs are seldom killed until they arrive at a certain age, on account of deficiency of flavour. In young animals, not only is the fibrin more tender and delicate, but the fat in quadrupeds is distributed differently from what it is when they are older. In the latter case, it is chiefly collected in layers external to the muscles; in the former, it is more dispersed through the muscles, so as to give the flesh a marbled appearance, which renders it more desirable for the table. This mixture of marbling never happens in birds. But though the flesh of young animals is more tender, it is not always more digestible; on the contrary, veal is less digestible than beef, lamb than mutton. Birds are most easily digested when young. It is on account of the greater proportion of gelatin contained in the calf than in the full-grown animal, that the feet of the former are employed for preparing strong jellies; and every one must have observed how much more gelatin is contained in the soup made from veal than in that from beef.

1813. *Sex.*—The flesh of the female is almost always more delicate and finer-grained than that of the male, which is often strong-tasted.

By a particular process in reference to sex, at an early age, in all animals, quadrupeds, birds, and even fishes, a remarkable alteration takes place in the flesh. It is much improved for the table, becoming fatter, larger, more tender, and more easy of digestion; there is also a greater deposition of fat between the fibres, as we see in the ox, capon, pullet, &c.

1814. *Season.*—It is well known that certain kinds of animal food are not always *in season*, that is, equally good at all times of the year. This is owing to many causes, according to the species of animal. The abundance or scarcity of food at particular seasons affects the condition of some kinds: thus, full-grown cattle, in general, are in the best condition in the first winter months, in consequence of their having had the advantage of plenty of fresh summer food. After that, the turnips and other vegetables on which they are fed, in consequence of the deficiency of grass, injures the flavour of the meat; and in spring it becomes lean from bad or insufficient provender. It is so managed that tolerable beef and mutton are always to be had in London, and they are there never absolutely out of season; yet they are, in general, best in November, December, and January. Females, in general, are out of season when they are suckling, or have lately suckled. The condition of quadrupeds is not much affected during the first months of pregnancy, and the time when they are most in season is that when the young have acquired the proper age for being killed. This is naturally in the summer months, when lamb, veal, kid, and fawn are most abundant. Though there is a season of the year when each species of animal is more naturally inclined to breed, yet, by treating them in a certain manner, this season may be advanced artificially. Thus breeders contrive to procure lamb, as an article of luxury, as early as November and December; certain breeds, as the Dorsetshire, are selected for this purpose; on the contrary, by keeping the ewes on cold, poor hill pasture, the lambing season is retarded.

1815. *The manner in which animals are fed*, and the food upon which they are kept, affect considerably, as we might expect, the fatness and flavour of the flesh, and its fitness for nutriment. The improvement of animals by careful breeding has been very considerable; but it has not always the same objects in view. Some of the methods affect the size of animals; but, though these produce a greater quantity, they do not always improve the quality of the flesh. Thus, sheep fed in the rich pastures of Lincolnshire grow large and fat, and produce much wool; but the meat is coarse, insipid, and rank, compared with smaller breeds. The flesh of well-formed, small animals, both of cattle and sheep, is finer grained, has a finer flavour, is more intermixed or marbled with fat, and affords a richer gravy than that of large animals of the same species. It is well known that the Welsh mutton fed on the hills, where there is short grass and wild herbs, is high-flavoured, and tender without being fat.

The flesh of all cattle fed in stalls, particularly when oil-cake is used, is not of so fine a flavour, and in some cases, probably, not so wholesome, as of those which have daily exercise in the open air, since the fat produced by confinement is often a species of disease. Fresh air and exercise are essential to the life and health of every living creature; and this is, no doubt, one reason why the mutton from sheep fed upon downs and mountains, which have a long way to roam for food, is superior to any other in high flavour, although it be lean. Methods of fattening are often resorted to, unnatural, and even cruel. Some of the means depend upon supplying the animals with a great quantity of food, and depriving them of exercise. Ducks and geese are prevented from

going into the water, which would hinder them from becoming fat. Fowls are fattened for the London market by keeping them in a dark place, and cramming them with a paste made of barley meal, mutton suet, with some treacle or coarse sugar mixed with milk, which in a fortnight has the desired effect. If kept in this manner for a longer time, the fever that is brought on by this mode of treatment renders the flesh red, and often kills them. The flesh of poultry fed in this way is never so well flavoured as when they run loose in the barn yard, and probably it is not so salubrious.

1816. *The methods resorted to by epicures* to produce an unnatural enlargement of particular parts of some animals—as the livers of geese and turkeys—are so cruel that we do not think it necessary to record them, as we never wish to see the palate gratified at the expense of so great a loss of feeling as must be the result of such practices.

1817. *Animals seldom become fat in their wild state*; but, from the quantity of exercise which they take, and the free air which they breathe, they are, generally speaking, in a more healthy condition than those which are domesticated; and their flesh, though tougher, more fibrous, and sinewy, has often a higher flavour, and is more nutritive. Their good qualities as food are improved by exercise previous to their being killed, as is the case in the hunting of game. Wild birds are more highly flavoured than fowls which are domesticated.

1818. *The mode of killing animals has a considerable influence upon the quality and flavour of the flesh.* Animals that die a natural death should never be eaten, as their death is generally the consequence of disease, and their flesh is then unwholesome; and it was a wise injunction of the Jewish legislator not to use these as food. This observation, however, does not apply to the case of animals being killed by accident, as by being drowned, hanged, or frozen, by a fall, or by a ferocious animal; these are only defective in being not at all or imperfectly bled, which is the case with those that are snared, and with such as are killed by hounds.

Whatever exhausts or destroys suddenly the irritability of the living muscular fibre tends to induce rapid decomposition: thus, when animals are killed by lightning, putrefaction soon takes place.

This is the case, likewise, with animals killed after being long hunted: the violent exercise they undergo exhausts the irritability, and causes the fibre to be less rigid, or more tender after death, from the greater liability to decomposition. Formerly it was a barbarous custom, sanctioned by an express law, that all bulls were hunted or baited with dogs previous to being slaughtered, from the known fact that baiting or hunting had the effect of rendering the meat more tender; but this cruel and dangerous practice is now very properly laid aside. The completeness of the bleeding, or emptying the vessels of blood, appears to be important; as, when the meat has not been well bled, it changes sooner, and is dark-coloured. Veal and pork, particularly, depend much upon the bleeding for their whiteness; accordingly, most of the animals slaughtered for food are either bled to death, or are bled as soon as possible after being killed in some other way. The Jews bleed their meat more completely than Christians, on account of their law which forbids them to eat blood.

1819. *The method of slaughtering large animals among us* is this: They are commonly kept without food for some time; because, if killed with full stomachs, their flesh is considered not to keep well. Oxen are made to fast for two or three days; smaller animals, as calves and sheep, for a day: but if this practice be carried too far, the object will be defeated, by the animals falling off or becoming feverish.

Oxen are killed by striking them on the forehead with a pole-axe, to stun them and cause them to fall, and they are then bled by dividing the blood-vessels of the throat. As this method has the appearance of cruelty, and is not free from danger if the operation is unskilfully performed, some, and in particular Lord Somerville, have recommended a mode practised in Barbary, Spain, and Portugal, called *pithing*, which consists in thrusting a sharp knife at once into the spinal marrow above the origin of the phrenic nerves, by which the animal drops down in an instant without the smallest struggle, after which it is bled by dividing the arteries about the heart. Notwithstanding the apparent advantages of this mode, it is but little employed in Britain; and it is said that the method is only apparently less cruel; for, though the puncture of the spinal marrow renders the body motionless, it does not destroy feeling, and that the animal is even made to die a more painful death; whereas, in the usual method, a concussion of the brain is caused by the blow, by which all feeling is destroyed. It is said also that the flesh of cattle killed by pithing is dark-coloured, owing to imperfect bleeding, as the action of the heart ceases before the bleeding is attempted, in consequence of which the blood does not flow freely.

The method of slaughtering practised by the Jews is very effectual in bleeding completely; and they will not eat flesh except the animal has been killed by one of their own persuasion. Their method is to tie all the four feet of the animal together, bring it to the ground, and, turning back its head, cut the throat at once with a long and extremely sharp knife, in consequence of which all the blood-vessels are severed, and the blood is discharged quickly and completely. All calves, pigs, sheep, and lambs are killed by dividing the blood-vessels of the neck.

1820. *It is highly desirable that, in adopting the most judicious method of performing such necessary operations*, all unnecessary cruelty should be avoided, not only on account of the animals themselves, but also of the bad effect produced on the minds of those who have to practise the art of butchery. It has been stated that some butchers resort to cruel practises; such as suspending calves by the hind legs with the heads downward, and bleeding them thus to death slowly for the purpose of whitening the veal.

1821. *Sheep and some other animals appear to have an instinctive dread of blood*, and cannot be readily induced to go where it is found in their track, on which account it is extremely difficult to make them enter slaughter-houses, which has given rise to scenes of uproar and brutality. The Society for the Prevention of Cruelty to Animals have recently carried plans into practice in Whitechapel market which, in a great measure, obviate this difficulty. They take care to place hurdles covered with straw over the kennels on market days; and near the entrance of the slaughter-house a skin of a sheep, stuffed so as to resemble the living animal, is placed on wheels and kept in motion: this is readily followed by the sheep, without the necessity of employing coercion by men and dogs.

CHAPTER III.

QUADRUPEDS USED AS FOOD.

SECT. I.—INTRODUCTION.

1822. *Quadrupeds are divided into two great classes*, according to the substances on which they subsist, which modify, in a considerable degree, their properties when employed as human food. These are the *carnivorous* and *herbivorous* classes, or those which feed upon the flesh of other animals, and those which live on vegetables. Beasts of prey are generally lean: their fibres are tough, and the flesh coarse and disagreeable: they are never employed as food in any part of the world, except among savage tribes, or in cases of necessity. Herbivorous animals afford the most agreeable, as well as the most wholesome nutriment. Animals of these classes do not readily change the nature of their food, yet, when they are brought to do so by the influence of domestication, their flesh partakes of this change. Thus dogs, which are naturally carnivorous animals, when fed entirely upon vegetables, as in the islands of the Pacific, were found by Europeans to be excellent when cooked. Some animals are partly carnivorous and partly herbivorous: of this kind is the hog. The bear is chiefly a carnivorous genus; but the brown bear, parts of which are eaten in Northern Russia, and also in North America, is an herbivorous animal.

1823. *The flesh of quadrupeds varies considerably in colour, and occasions a distinction between red or brown, and white meats.* The red colour, when raw, depends upon having a great number of small arteries, and, consequently, more globules of red blood, interspersed among the muscular fibres. White meats are considered as the least stimulating, and, in general, are the most gelatinous. The effect produced upon different animals by the food with which they are supported, as well as other circumstances relating to their habits, have been carefully described by naturalists. It is remarkable that all the researches of travellers, aided by the lights of zoological science, have hitherto failed to ascertain the true originals of most of our domesticated animals; and it is known that some of these no longer exist but as the servants of mankind.

1824. *The supply of animal food to the United Kingdom* has of late years very much increased, and, of course, the consumption. This must be attributed to the improvements in agriculture, particularly the extension of the turnip and clover cultivation, by which a greater abundance of food for the cattle has been produced: the breeds have also been improved in the weight and quantity of the meat and of the milk. This kind of melioration began in the last century, and was the result, in a great measure, of the skill and enterprise of Mr. Bakewell of Dishley, and Mr. Culley of Northumberland. Their success roused a spirit of emulation, and the rapid increase of wealth arising from commerce and manufactures produced a greater demand for butcher's meat.

1825. In the following description of quadrupeds employed as food, we shall first describe at length those which are consumed in Great Britain, and then slightly notice some others that are not used for this purpose among us, although they are in some parts of the world

SECT. II.—THE OX (*Bos*, Linn.).

1826. *The tribe of animals which naturalists designate by the name of Bos consists of several species*, each of which is divided into many varieties, which arise from climate, domestication, and other causes. The principal species are the common domesticated ox, the buffalo, and the bison: the first only is known to Britain.

1827. *The common domestic ox* (*Bos taurus*, Linn.), in the earliest ages of society, became an object of interest and regard; for we read in Genesis that "there was a strife between the herdsmen of Abraham's cattle and the herdsmen of Lot's cattle;" the flocks of each of which were so numerous that "the land was not able to bear them, and they could not dwell together." The ox became a propitiatory sacrifice in the case of Abel's offering up the firstlings of his flock, and Abraham was directed to sacrifice a heifer as an offering for the promise of a son. This animal was held sacred by the Egyptians, and elevated into one of the twelve signs of the zodiac (Taurus); a representation of the ox became an object of idolatrous worship, as in the golden calf erected by Aaron. At this day among the Hindoos in India the cow is sacred, and held in the highest veneration; the flesh is forbidden to be eaten. All these instances prove the value and great importance of this animal in the earliest times; nor is this to be wondered at when we consider the various advantages we derive from this useful animal. The flesh affords the most nutritive, wholesome, and generally used animal food, and every part of its body is applied to some economical purpose. The hide is tanned into durable leather; even the hair is employed to mix with mortar; the tallow affords us artificial light; the horns are manufactured into a variety of useful and ornamental articles, and the refuse of these and of the skins is made into glue; the intestines and the bladder are brought

into use in domestic economy; the bones are formed into various implements, being a substitute for ivory, and are employed as a valuable manure. The female supplies us with milk, the most nutritious of aliments; and as a beast of burden and draught, or even for riding, the ox is employed in many countries, where its patience and docility are acknowledged. Another of the advantages of this quadruped consists in its being so readily acclimated in almost every part of the world: in the Northern parts of Europe, and also under a tropical sun, the ox is found domesticated, and the servant of man.

1828. *The early history of the ox in this island* partakes of the same obscurity with that of its human inhabitants. Cæsar describes the Britons in his invasion as subsisting chiefly on milk and flesh; and this animal is doubtless indigenous here. There are several varieties, usually termed breeds, of it in the domesticated state; and, although they are all descended from one common stock, it is now uncertain what was the original, if, indeed, it still exists. These varieties have been produced by cultivation, and care is still taken to preserve the different breeds as perfect as possible; yet by intermixture, and various improvements, the varieties have now become numerous. Of late great improvements have been made in cattle, both for the dairy and the butcher.

1829. *The different breeds are chiefly distinguished by the presence or absence of horns, or by their length and flexure, and by the various proportions of the parts of the body.* It is observed, in general, that long-horned cattle give beef of the finest grain, more mixed and marbled than the short-horned, but affording less tallow. The short-horned give the richest milk; a cow of the short-horned Yorkshire breed will yield twenty-four quarts of milk per day. The Galloway breed, which is without horns, and small, affords beef of the finest quality; and many of these are annually driven to England, four hundred miles from their native pastures, and sold to the butcher. The Ayrshire breed appears to be the most improved in this island, not only for the dairy, but in feeding for the shambles. The Alderney cows, with the crumpled horn, give the richest milk, though small in quantity. The Hereford cow gives a large quantity of milk.

1830. *The quality of the beef depends upon a variety of circumstances,* such as the breed, the sex, the age of the animal, and likewise upon the food with which it has been supplied. *Bull beef* has a strong, disagreeable flavour, dry, tough, and difficult of solution; it is rarely eaten, except in sausages. The flesh of the *ox* is more soluble; the fat is better mixed; the meat is more sapid; it is highly nourishing and digestible, if the animal was not too old. The flesh of the *cow* is sufficiently fit for nourishment, but it is inferior to ox beef; *heifer* beef, or that of the young cow, is much esteemed, but that of an old fatted cow is bad. The larger varieties of the animal are inferior in the delicacy of their beef to that of the smaller breeds, when the latter have been properly fattened. The beef of the larger breeds of oxen is in perfection when the animal is about seven years old; that of the smaller breeds a year or two sooner; cow beef, on the contrary, can scarcely be too young. It is remarkable that a tendency to fatten, and to give a large quantity of milk, are never united in the same animal. As marking the distinctions among domestic animals, they are often denominated *neat cattle*, and sometimes *black cattle*.

1831. *The food upon which cattle are fatted* in summer is grass, commonly on pastures, but in some instances cut and consumed in feeding-houses or fold-yards. In winter, by far the greater number are fattened on turnips and other roots, as carrots and potatoes, along with hay and straw. Oil-cakes, and other articles, are used occasionally. A considerable number of cattle are also fatted on the grains from distilleries. There is a very large establishment for this purpose at Booth's distillery, in Brentford, calculated to hold six hundred head of cattle, that are fattened upon grains, and mashes of barley-meal and clover-chaff, with a little green food. It is said that a very large proportion of the beef sold in the London markets is from stall-fed cattle living upon oil-cake and grains, a sort of food that is well known not to produce meat of the finest flavour, though it may in this manner be made sufficiently or even extremely fat. London is partly supplied by cattle which has been brought in a lean state from Scotland, Wales, and Devon, and fattened in the rich pasture of Essex; but there is a great quantity of dead meat sent up from the country, generally speaking perfectly wholesome, and fairly and honestly slaughtered, although it is said that the flesh of some animals that did not come to their death by the hands of man has occasionally found its way to the London market. There are inspectors appointed, who very impartially look after this: a place in Newgate market is called the "dead market." Cattle are generally fatted in three months ready for the butcher, though, from improvements in agriculture, they can be supplied with food at all times of the year, and hence good beef is always to be had in the metropolis; yet it is generally best everywhere in the first of the winter months, that is, in November, December, and January. The cattle fed out of doors are then in the best condition, after having had the advantage of plenty of grass and summer food. In the winter, from the turnips and other vegetables on which they feed, the meat often acquires a worse flavour, and in the spring it is apt to be lean from the quality and insufficiency of nutriment. The loin is generally reckoned the finest part of beef, called *sirloin*, from having been jocularly knighted by Charles II. Two sirloins make a *baron*.

1832. *Veal*, or the flesh of the calf, is tender and nourishing, but not so easy of digestion as the prime parts of beef and mutton, although the contrary is often supposed. Veal, particularly if it be young, contains much gelatin, as is the case with all young animals, and therefore yields a great deal of soluble extract when boiled long in water, particularly if under two months old, and is, in consequence, much used for soup or broth, which has occasioned it to be supposed that veal is more nourishing than meat less soluble; but this does not follow, for the gastric juice in the human stomach acts differently from water, and can dissolve what that fluid cannot.

There is the same difference in the quality of veal as of beef, arising from the mode in which the calves have been reared. The method most commonly employed for fattening them is to allow them to suck, which is the quickest and most effectual. Another method is to give them milk, and then they are kept in pens in a close house well littered. These two methods, when well managed, are nearly equal. When calves are killed too young the veal is insipid; it is best when the animals arrive at the age of eight or ten weeks, according to the season of the year. Calves of the largest size are fatted in Essex, where the business of suckling seems to be best understood. All that appears necessary, however, is to give them abundance of milk, and to keep them clean and dry in good air.

Whiteness is generally considered as a test of the goodness of veal. This, however, is not always a true one, since the butchers, it is said, sometimes produce whiteness by frequently bleeding the calves. Veal does not keep so well as beef and mutton. If ill-fed, its flesh is sometimes red; but the bleeding which is resorted to, in order to improve the whiteness, is of no avail in making it more wholesome. It is a common practice to give chalk to calves that they may lick it, and it is erroneously supposed by some persons that this is intended to make the flesh white; but the use of chalk is to correct the acidity which sometimes exists in the stomach, and which prevents their fattening.

In the immediate neighbourhood of London, where the fatting of calves is an object of great importance, milk is too valuable for feeding them, and a great variety of other food is resorted to. They are generally fattened with balls of linseed jelly, gruel, grains, potatoes, pollard, and some other nourishing preparations, with hay tea to drink.

1833. *It has been remarked that most of our animals serving as food* preserve their Saxon names while living; but when they are killed and dressed their names immediately become French. Thus, it is *ox*, *calf*, *sheep*, *deer*, and *pig*, while alive, but *beef*, *veal*, *mutton*, *venison*, and *pork* when brought to table. This might arise from the superiority of our neighbours in the art of cookery, which gave rise to the names of our dishes, though not to the animals from which they were derived.

1834. *The terms applied to cattle of different ages* are, when male, a *bull*, or *bullock*; when castrated, after the first year, a *stirk*; a year old, a *stot* or *steer*; at five years old, an *ox*: female, a *cow*; first year, a *calf*; after the first year, a *heifer*; when about to bring a calf, a *young cow*. A castrated female is called a *spayed heifer*. Certain of the Welsh and Scotch cattle of rather a sturdy kind are often called *runts*.

Sect. III.—sheep (*Ovis aries*, Linn.).

1835. *The sheep was probably one of the earliest domesticated animals*, owing to its gentleness of character, and it appears to have formed the principal wealth of the patriarchal tribes. They were spread over Western Asia at a very remote period: but it is not known at what time they were introduced into Europe. Sheep have an advantage over most other quadrupeds, that they can be reared in situations and upon soils where black cattle could not live from the scantiness of the herbage; and in usefulness they may rank next to the cow. They are found in almost every part of the world, and their fleece varies remarkably, according to the temperature of the climate. In cold countries the wool is extremely fine, while in warm regions it is little better than hair, nature adapting the covering of the animal to the necessity of its being kept warmer or cooler. It is not a little remarkable that the domesticated sheep depends almost entirely upon man for his support; left to itself, it becomes the subject of disease and the prey of ferocious beasts.

1836. *The varieties of sheep that are dispersed over the globe are almost endless*; even in this country they are so numerous as scarcely to be described with accuracy. Of the varieties of British sheep, some are particularly valuable on account of their fleeces, and others for the good quality of the mutton which they afford. Some are of large size, and fatten readily; others are of a smaller breed, and, though they do not become so fat, they are distinguished by the fine flavour of their meat. The English breeds may be divided generally into, 1, the *mountain breed*, as those in Wales and the Highlands of Scotland; 2, the *short-woolled breed*, as the south-down and Norfolk; and, 3, the *long-woolled breed*, as the Leicestershire sheep. It is not certain what was the original stock.

1837. *The quality of the mutton varies much in the different breeds.* In the large, long-haired sheep it is coarse-grained, but disposed to be fat. In the smaller, and short-woolled breed, the flesh is closest grained and highest flavoured; but the quality of the

flesh is probably most affected by that of the food upon which the flocks are fed. Those which range over the mountainous districts of Wales and Scotland, or the chalk downs of England, and feed upon the wild herbage, possess a flavour very superior to those kept in rich pastures and on marsh land. The Welsh mutton is particularly small and lean, but of the finest flavour, and the south-down mutton is also excellent. Marsh-fed mutton often becomes extremely fat, but the meat has a rank taste. Turnips, hay, chaff, bran, corn, and other vegetables, as likewise oil-cake and grains, are employed for fattening sheep for the market; but such mutton is never so good as that produced where the animals can range in freedom. It is to be observed that the management favourable for cultivating long wool is unfavourable for the production of fine mutton.

1838. *Mutton, as food,* is considered as highly nutritious, light, and easy of digestion; but *tup mutton*, or the flesh of the ram, has a strong, disagreeable flavour, and is usually very tough. *Ewe mutton* is good if under two years old; but after that, when the ewes are called *crones*, the mutton becomes coarse and tough. The mutton of the *wedder* is the most esteemed. In sheep, more than in any other animal, the meat improves in a certain advanced period of its life. It is in perfection at five years old, and is not so good younger. It is then sapid, full-flavoured, and firm, without being tough, and the fat has become hard. At three years old, as commonly procured from the butcher, it is well tasted, but is by no means comparable to that at five years. Mutton younger than three years is deficient in flavour, and is pale in colour. Meat which is half mutton and half lamb is very unpalatable. Mr. Ude says, "Always choose mutton of a dark colour, and marble-like." The hind quarter, or the leg, when intended for roasting, is generally hung up in winter for several weeks, with the view of making it more tender, or in summer as long as it can be kept without a taint. By this a dark colour is induced.

1839. *Sheep are liable to many diseases,* but none of these is so fatal as what is named the *rot*, which often carries off immense numbers, and is supposed to be produced by the wetness of the soil on which they feed. The mutton of such sheep as die of this disease is unfit for food.

1840. *In England, the working classes often prefer very fat mutton,* which they cook with vegetables, particularly potatoes; but this is certainly not so wholesome and nutritious as meat somewhat leaner, and it is seldom or never brought to the tables of the affluent.

1841. *Lamb, as food,* is milder, more tender, and less exciting than mutton. Lambs are sometimes fatted on grass for the butcher, and sometimes reared by suckling, or by hand, on milk. Those which are suckled by the mothers, and fattened in houses, and hence called *house lamb*, are the earliest in the spring season, beginning to be ready in December, and continuing till February, before the natural lambing season commences; but in great towns it may be had almost all the year round. The Dorsetshire breed of sheep has the peculiar property of producing lambs at almost any period of the year, and they are particularly valued for supplying the London market, through the year, with house lamb. If lambs are allowed to be suckled by their mothers for six months, or a little more (and it is the same thing with veal), the flesh becomes more nourishing and digestible than if they are weaned at two months, as they generally are. As in all similar cases, great attention to cleanliness, and to giving plenty of nourishing food, are found to effect the objects of rearing most expeditiously and completely.

1842. *The grass-fed lamb* comes next in season, in April and May, and continues till Christmas.

1843. *It is sometimes the practice of farmers to manage the ewes* so that they may produce lambs almost at any time of the year, long before the natural season, and as early as September and October; and, by keeping them in cold or hilly pastures, retard their lambing until November and December.

1844. *A species of sheep is common in Asia Minor,* as at Aleppo, and likewise in the south of Africa, remarkable for their *large and fat tails*. This part of the animals in these countries consists almost entirely of a mass of substance between fat and marrow, which is used in cooking, and often instead of butter. One of these tails will often weigh from twenty to fifty pounds; and when they are very large, it is customary to fix a piece of thin board beneath to carry the tail, and prevent injury to it, as the under side is not covered with thick wool like the upper. Some have even little cars which they fix to the sheep to lay their enormous tails upon.

Sect. IV.—Swine or Hog (*Sus scrofa*, Linn.).

1845. *The swine, pig, or hog is one of the most useful of all the domestic quadrupeds,* and its flesh forms the chief animal food among the labouring classes. The wild hog, or *boar*, is about the same size as the domesticated breeds, but is distinguished by its ferocity and the superior length of his tusks, which form very dangerous weapons. Hunting the wild boar is still an amusement on the Continent, as it was with our ancestors.

1846. *All our domesticated breeds are derived from the original stock of the wild boar,* which still exists in the forests of Germany and other parts of Europe, and was formerly common in Britain, though now extinct. Tame hogs are found in most countries, except where the cold is very severe.

1847. *We have several varieties of the hog,* produced by crossing our indigenous breed with foreign ones, as the Chinese, black African, the Spanish, and the Portuguese, which have improved our own, by giving them greater delicacy of flesh and aptitude to fatten. The greatest improvement in pork has been received from crosses with the southern stock, or with the wild boar of the Continent.

The fat of the hog differs from that of every other quadruped, not only in its consistence and quality, but in its mode of distribution over the animal's body; the fat of those animals that have no suet, as the dog and the horse, is equally mixed with the flesh; but the fat of the hog covers the animal nearly all over, and forms a thick and continuous layer between the flesh and the skin.

1848. *The well-known culinary division of swine's flesh* is into *roasting pig*, *pork, fresh* and *pickled*, *bacon*, and *ham*; and hogs are generally fed and killed with a view of being chiefly employed in one or other of these ways. The large breeds answer best for bacon hogs, producing the finest flitches, and the smaller for fresh or pickled pork.

1849. *Swine have different names according to the age at which they* are sold to the butcher. They are called *pigs* when a few weeks old, and these are commonly roasted whole. *Porkers* are of the age of five or six months, and are used as fresh or as pickled pork, and not made into bacon. Full-grown *hogs*, named *bacon hogs*, are from eighteen months to two years old, and are converted into ham and bacon. For the manner of preparing these, see "Preservation of Food."

1850. *The flesh of the hog* has been variously esteemed among different nations. It was highly valued in ancient Rome, but is held in abhorrence by the Jew and the Turk. In hot climates its flesh is not good; and the animal being there subject to scrofula and leprous disorders, and from its habits generally considered as an emblem of filth, sloth, and gluttony, it has been reckoned unclean; and this will account for its proscription by the legislators of the East. But no other animal affords a larger series of savoury viands to the table of the European Christian. Every part comes into use. Of the backbone are made the chine and the griskin; the thinner portions of the ribs form the spare-rib; the sides make the flitch; the hind legs the ham and the hock; the neck and collar make brawn; of the shoulders are made gammons and bladebones; the sides of the head are called cheeks; the tongue is pickled, and the ears are made into souse; of the heart, the liver, and lights, with morsels from the throat, are made the harslet or fry; of the spare lean parts are made sausages; the larger intestines, stuffed with grits, mixed with the blood, make black puddings; the smaller intestines make chitterlings; and the feet of the sucking-pig furnish the petitoes.

The flesh of the wild boar is of a higher flavour than that of tho domestic hog, and was formerly very much esteemed when existing in this island. The boar's head was considered as a great delicacy; and the finest Westphalia hams are still made from the wild boar.

1851. *Pork and bacon, like other kinds of meat, vary* according to sex, age, and feeding. The flesh of the sow is strong, and makes bad bacon; it is the flesh of the male that is in common use for the best pork. Pork, in general, is a very savoury food, and is much relished in England, though not among our northern neighbours. It is, however, with some persons, not very easy of digestion, although others digest it readily; and it is, upon the whole, not the most wholesome food. Although for bacon a great deal of fat may do, and even be preferred by some, yet for roast pork the fat should never exceed a certain proportion, and there should always be a considerable quantity of lean. In very fat pork, the little lean there may be is of a greasy quality and insipid flavour. Bacon is nutritive and easily digested by robust, labouring people; but it excites much thirst if eaten in quantity, and is probably too much used in England. The hog differs from all other land animals, with respect to the adipose substance, or fat: some bacon consists almost entirely of fat, and would demand the addition of much vegetable aliment to form wholesome food.

1852. *No animal is more affected, as to the wholesomeness of its flesh, by the mode of keeping than the hog.* It is naturally indolent and filthy in its habits; yet, perhaps, no domestic animals are more pleased with a clean and comfortable sty, and on none is the advantage of cleanliness more obvious in making them thrive. The kind of food given to swine has a very great influence on the quality of the flesh. Skimmed milk and peas, oats and barley meal, rank first in excellence as food for making delicate pork. Milk will fatten pigs entirely without the addition of any other substance: a practice sometimes followed in the dairies; and milk-fed pork is the most delicate of any. Corn-fed pork is next in value; peas, oats, and barley being the best adapted grain. Pork fed on beans is hard and ill-flavoured; that which is fed entirely on grains has the fat spongy; fermented grains and the must of cider render the hogs bloated, and liable to fits of the gout, from being kept in a state of constant intoxication. Potatoes make a light, insipid flesh; hence the Irish pork and bacon is inferior to the English, and the market price is in proportion. Oil-cakes make a flesh little better than carrion; and butchers' offal causes the flesh to be full of gravy, but to have a disgusting strong taste and smell. For bacon and flitches, the hogs are fattened on purpose, and then their food will depend on the circumstances of their owners. In breweries and distilleries, grains, and in dairies, buttermilk, form the chief part of their food: with farmers, the food is turnips, potatoes, grains, and whatever happens to be the produce of the farm. Compared with the general consumption of pork, the real *dairy-fed* meat bears a very small proportion, and the sale of it in the metropolis is in very few hands, and always commands a superior price.

Round the forests in England it is the custom to drive the pigs in at the proper season, that they may feed on acorns and various kernels which fall from the trees. It is said that the Westphalia hams owe much of their excellence to a similar practice. The astringent property of acorns may, perhaps, harden the flesh, and communicate a peculiar flavour.

1853. *Of all animal food, pork takes salt best, and preserves best:* hence its great use in naval stores. A smaller quantity of salt will keep it than any other meat; it acquires saltness more slowly than any other; and with the same degree of saltness it remains succulent and sapid.

1854. *The hog is a very prolific animal, and of very rapid growth,* consequently no other article of flesh provision can be raised and prepared for market so soon and at so little expense as pork: in consequence, it must be materially instrumental in the production of plenty, and in restraining the exorbitant price of the first necessaries.

A remarkable instance of the fecundity of these animals occurred in this country lately. A sow belonging to Mr. Thomas Rishdale, Kegworth, Leicestershire, had produced in the year 1797 three hundred and fifty-five young ones in twenty litters.

Leicestershire, Northamptonshire, and Hampshire are famous for hogs, which seems owing to their being clayey counties, where much peas and beans are sown. The Western pigs, chiefly of Berks, Oxford, and Bucks, make excellent bacon and hams; but the pork of Essex, Suffolk, and Norfolk is smallest, and most delicate for roasting, &c. The demand for porkers in London, which is very great, and continued throughout the year, is chiefly supplied from the dairies within reach of the metropolis; but the winter months are the principal for pork or pig meat. Swine for pork are killed at from six to twelve months old.

1855. *This animal affords a preparation called brawn,* that cannot be made from any other. It consists chiefly of the adipose membrane, or that which contains the fat, rolled up and closely compressed, so that much of the oil is squeezed out, whilo the cellular texture remains so closely united as to form a semi-transparent substance. It is very nutritive for those persons whose stomachs can dissolve it.

1856. *Sucking pigs* are killed when about three weeks old. They are fattened with milk and whey, with the addition of barley meal. By some persons their flesh is considered as a great delicacy; by others it is found to be too luscious; it is very nutritive, but not so readily dissolved in the stomach as might be supposed. They may be had in London all the year round, but are not reckoned wholesome in hot weather.

Sect. V.—Deer (*Cervus*, Linn.).

1857. The old huntsmen called the flesh of every animal that was hunted *venison;* but with us this term is restricted to animals of the *deer* kind.

In the hunter state of society, men chiefly subsisted on the produce of the chase; they lived much upon venison, which is certainly not only a delicious, but a nutritive and wholesome food. Fallow deer is, upon the whole, the best, though the flesh of the wild stag is the highest flavoured, and very palatable in autumn, when it is in its most perfect state.

1858. *There are three species of deer in this country:* the stag, the roe, and the fallow or common deer.

1859. *The stag, or red deer* (*Cervus Elephas,* Linn.), is the largest of our deer tribe. It is found in nearly all the temperate countries of Europe, particularly the woody parts of Germany; it is also met with in Asia and North America, but attains its largest size in Siberia. From the branchiness of its horns, which are divided into many round and sharp-pointed processes, the elegance of its form and movements, and the strength of its limbs, it may be regarded as one of the principal embellishments of the forest. This animal, the colour of which is a strong reddish brown, is supposed to have been introduced into England from France; and the hunting of the stag was formerly a favourite diversion with royalty and the nobles; but, being of a nature sometimes extremely fierce, it has latterly been made to give way to the fallow deer, much more gentle in its manners, and more valuable as food. At present it is rarely to be found in England; but in the Highlands of Scotland it yet exists in its original wild state. A stag of five years old is called a *hart;* the females are termed *hinds;* and the young ones are *fawns.* This species is considered by some as affording the most sapid venison; but it is usually lean, and rather tough.

1860. *The fallow deer* (*C. Dama,* Linn.) is smaller than the stag, and it has great elegance, connected with a much more tractable disposition. It abounds in almost all parts of Europe, except in the cold regions of the North, where its place is supplied by the reindeer.

It is said to have been first introduced into Scotland by King James I., out of Norway, and afterward placed in his chases of Enfield and Epping. It is scarcely seen in France and Germany, and has never been known to exist in America. In Spain these deer are extremely large; and they are met with in Greece and China; but in every country, except our own, they are in a state of natural wildness.

The fallow deer, so called from an early word, *falow,* to be pale, is the species generally seen in our parks, where they are confined; but some have kept them in a small yard with a shed, and fattened them in the same manner as cattle for their venison. There are several varieties, as the Spanish deer, the mottled deer, and the Virginian deer. The fallow deer is distinguished by having the horns dilated into a broad, flat, subdivided expanse at the upper parts.

The *buck* of the fallow deer may be killed at six years old, but is better at eight years of age. The female, in general, being naturally more tender, and getting tough rather than mellowing by age, is sooner in perfection.

1861. *The males of the deer tribe are in highest season* from the middle of June to the middle of September, after which they become thin and exhausted. Buck venison is preferred as the choicest meat, and the haunch as the finest joint. Does which have had no kid, or soon deprived of it, are in season from the middle of November to the middle of February. Venison is more sapid than any butcher's meat, and is considered as very digestible. Its grain resembles most that of mutton, but its taste is different.

1862. *The roe deer* (*C. Capreolus*, Linn.) is the smallest of the deer tribe that are natives of Europe. It is generally of a reddish-brown colour, and differs in character from the stag and fallow deer. Instead of herding together, they go in separate families. It is never tamed, and is to be found at present only in a few districts of the Highlands, delighting in vales, as the fallow deer does in plains. Venison of the roe buck is excellent when the animal is in good order, but otherwise it is but indifferent and lean: after two years of age, that of the males is tough.

1863. *The moose deer, or elk*, of Northern Europe and America (*Cervus Alces*, Linn.), affords a venison that is extremely sweet and nourishing. The Indians say they can travel three times farther after a meal of moose than of any other animal food. The tongue is excellent, and the nose is considered as the greatest delicacy in Canada. It is the largest of the deer tribe.

1864. *The reindeer* constitutes the chief wealth of the Laplanders, and supplies that simple and harmless people with many of the chief conveniences of life. Its flesh is excellent.

1865. *The horns of the deer tribe* are of the nature of bone, containing a large quantity of gelatin, which may be extracted by boiling, as is done in making hartshorn jelly; and they differ in this respect from the horns of the ox and sheep, which consist mostly of albumen, and can only be softened, but not dissolved, by water. The horns of the deer are cast off annually; a natural joint forming at their base, between them and the bones of the scull, with which they are connected. They are afterward reproduced, and, while young, are covered with a skin, serving as a periosteum, which the animal rubs off when the new horns have attained their proper size.

Section VI.—goat (*Capra Hircus*, Linn.).

1866. *The wild goat—the supposed original of our domestic species*—inhabits the mountains of Persia and the Caucasus. In its domestic state it is found in almost every part of the world, bearing the extremes of heat and cold, but differing in form according to circumstances. It is a hardy, active, and sprightly animal, possessed of more dexterity than the sheep. Unlike the sheep, the goat approaches man, is easily tamed and familiarized, and is capable of a considerable degree of attachment; but he prefers a wandering life, and to climb and sleep among rocky eminences. He is easily nourished, as he eats almost every plant, and is injured by few; but he does infinite harm to crops and young plantations by feeding on the shoots. The flesh, tallow, hair, skin, and milk are all valuable.

1867. *The domestic goat was anciently held in much estimation as food*; and in modern times, in districts where the animal is common, the haunches are frequently salted and dried, serving instead of bacon. The Welsh call it *hung venison*, to which it is little inferior. The meat of the wedder goat is best; and, under the name of *rock venison*, is supposed to be little inferior to the flesh of deer. It is reckoned peculiarly nutritious in soup. In the West Indies the flesh of both of the ewe and the wedder goat is accounted as good as mutton; and Sir John Sinclair remarks that, both on account of the milk it produces, and its flesh and skin, it is a pity that the West Indian goat is not more attended to in this country. The flesh of the kid is a delicacy everywhere, though not very sapid; in the East Indies it is preferred to lamb. *The suet* is whiter than that of the ox, and is preferable for candles. *The skin* is employed for various kinds of leather; and that of the kid is well known in gloves. *The milk* is abundant, and considered as more wholesome than that of any other animal; when mixed with cows' milk it makes excellent cheese. The goat is very prolific, bringing forth frequently two kids at a time, and often twice in a year. Formerly they were very plentiful in Wales, but they have given place to a small breed of sheep which are more profitable; at present very few goats are to be seen there. As an article of food, of course, the flesh of this animal is now rare in Britain.

1868. *The chamois* very much resembles the goat, and is one of the wildest and most timid of animals. Hunting it in the mountains of Switzerland is often a toilsome and dangerous employment; but its flesh is considered as good food, and a large one will weigh from fifty to seventy pounds. The Swiss salt and smoke the flesh; and the use of the skin is well known.

Section VII.—rabbit (*Lepus Cuniculus*, Linn.).

1869. *The rabbit* is an inhabitant of most temperate climates, but does not reach quite so far north as the hare.

1870. *The wild rabbit* is a native of this island, and is found in great numbers, burrow-

ing in dry, sandy soils, particularly if the situations be hilly or the ground irregular, such as the sandy districts of Norfolk and Cambridgeshire. Enclosures, called *warrens*, are frequently made in favourable spots of this kind, some of which extend to 2000 acres. Rabbits, not being swift-footed animals, are taken by nets, traps, ferrets, and dogs. The common wild rabbit is of a *gray* colour, and is the best for the purpose of food; its skin is valuable, as the pelt is a material for hats; but another variety has been lately introduced, the *silver gray*, the skin of which is more valuable, and is dressed as fur: the colour of this is a black ground thickly interspersed with single gray hairs: a great number of them are exported to China.

1871. *Tame rabbits are also reared* in hutches or boxes placed in apartments or sheds. They are easily fattened upon the same food as is given to cattle and sheep—roots, good green vegetables, hay, corn, and peas.

1872. *The flesh of the rabbit* differs somewhat according to its wild or domesticated state. There is some difference of opinion as to which is preferable. The wild rabbit has more flavour; but some prefer the tame one as whiter and more delicate. Wild rabbits are procurable young and in good condition only at particular seasons, as from the end of October to the beginning of January; but tame ones may be always bred in a state fit for the table. The latter are in greatest perfection when three months old; but, if well fed, will not be too old at eighteen months. The flesh of rabbits is inclined to be dry; but feeding them partly on green vegetables makes it more juicy. They become larger and fatter in the tame than in the wild state; but it is not desirable to have them as fat as they can be made. Some that have been fed in coops have been known to exceed a dozen pounds in weight. When very old they are tough, like the hare.

1873. *There are several varieties of tame rabbits.*—The large white and yellow, and white variety, have the whitest and most delicate flesh, and, when cooked in the same way, sometimes rival the turkey. There is also a large variety of the hare colour, the flesh of which is high-flavoured, and more savory than that of the common rabbit; and it makes a good dish cooked like the hare, which, at six or eight months old, it nearly equals in size. All these are to be had of the London dealers and poultry-men.

Rabbits may be easily bred in a small artificial warren where the ground is extremely dry and well drained by a ditch all round it, and having banks raised for the rabbits to burrow in. Food must be provided as when bred in hutches. They are more prolific in their domesticated than in their wild and exposed state.

1874. *The skins*, besides being saleable, are useful in a family for lining night-gowns, and other domestic purposes.

SECT. VIII.—HARE (*Lepus Timidus*, Linn.).

1875. *The common hare is found* over the whole of Europe, and in almost the whole of Asia, in North America, and even in Chili. In the polar regions it becomes white in the beginning of winter. It is usually a wild animal, and is taken by hunting in various modes; hence the price of the hare is much greater than that of the rabbit. It is seldom domesticated, though it is capable of being made extremely tame, and is then a remarkably playful animal. An attempt has been made to breed hares in warrens, like rabbits; and some are of opinion that this might be practicable in certain dry situations; but confinement always injures their flavour: those which live in mountains are superior to those which are found in low grounds. They do not burrow under ground, like rabbits, but make a slight depression, called their *form*, in which they rest: its quickness of sight and hearing, and its timidity, are well known.

1876. *Its flesh* is considered in many respects superior to that of the rabbit, being much more savoury, and of a higher flavour; it is, however, a dry kind of animal food, and requires much gravy, stuffing, &c., and this natural dryness is too often unnecessarily increased by the common practice of soaking it in water for some time before it is dressed, which deprives it of its juices. It is not fit for table immediately after being killed; but requires to hang up for some days to make the flesh tender. An old hare is excessively tough, and scarcely fit for stewing. It is less digestible than the flesh of the rabbit, and should not be eaten by dyspeptics. Ude directs, in order to ascertain whether a hare is young, "to feel the first joint of the fore claw: if you find a small nut, the animal is still young; should this nut have disappeared, turn the claw sideways, and if the joint cracks, that is a sign of its being still tender." Dolby says, "if the ears feel tender and pliable, and the claws smooth and sharp, the hare is young."

1877. *Hares are reckoned game*, and the *game laws*, which formerly were the source of much incentive to vice, were the remnant of the ancient forest laws, under which the killing one of the king's deer was a capital crime.

These laws declared what birds and beasts should be called game, and prohibited every one not duly qualified by birth or estate from killing any of them. By a statute passed in 1831, the old system was considerably modified. The whole of the former provisions respecting qualification by estate or birth were removed; and any person obtaining a certificate is now enabled to kill game either upon his own land or on the land of any other person with his permission. The sale of game is, under certain restrictions, legalized; and being deemed an article of legal traffic, summary means are provided for protecting it from trespasses. Poaching in the night-time still remains punishable by imprisonment for the first two offences, and by imprisonment or transportation for the third.

The word game includes hares, pheasants, partridges, grouse, heath or moor game, black game, and bustards; and the periods during which the different species of game may not be killed are those of the breeding and rearing seasons of the different species; penalties are imposed upon persons laying poison for game, or destroying the eggs of any bird of game, or of any swan, wild duck, teal, or widgeon, or knowingly having possession thereof.

CHAPTER IV.

MILK, BUTTER, AND CHEESE.

SECT. I.—MILK, AND THE VARIETIES OF FOOD PREPARED FROM IT.

SUBSECT. 1.—*General Remarks.*

1878. The general properties of milk are well known; but it will be useful to describe its chemical composition, and the various changes it undergoes; since it is in consequence of these that we are enabled to prepare from it so many articles of diet.

1879. *Milk is obtained only from the class of animals called Mammalia*, and is intended by nature for the nourishment of their young. The milk of each animal is distinguished by some peculiarities, but as that of the cow is by far the most useful to us in this part of the world, our first observations will be confined to that variety.

1880. *When the milk of the cow is taken away periodically*, the supply is continued for some time; and hence the great value of this animal to man, who is indebted to her for three of the most useful articles of food, milk, butter, and cheese.

SUBSECT. 2.—*Properties of Cow's Milk.*

1881. *Milk, when just drawn from the cow*, is of a yellowish white colour, and is the most yellow at the beginning of the period of lactation. Its taste is agreeable, and rather saccharine. The viscidity and specific gravity of milk are somewhat greater than that of water; but these properties vary somewhat in the milk procured from different individuals. On an average, the specific gravity of milk is 1.035, water being 1. The small cows of the Alderney breed afford the richest milk.

1882. *On comparing the milk of two cows*, in order to judge of their respective qualities, particular attention should be paid to the time that has elapsed since their calving, as the milk of the same cow is always thinner soon after that time than it is afterward; and it gradually becomes thicker, though less in quantity, in proportion to the time that has elapsed since the cow has calved.

1883. *The milk that is drawn first* at one milking is also thinner and of a worse quality than that obtained afterward; and the richness of the milk continues to increase progressively to the very last drop that can be obtained from the udder. It is even said that the last milk is at least eight or ten times richer than the first.

1884. *Milk which is carried to a considerable distance*, so as to be much agitated, and cooled before it is put into pans to settle for cream, never throws up so much, nor such rich cream, as if the same milk had been put into pans directly after it was milked.

1885. *When exposed to heat*, milk boils at 199°, water boiling at 212°; and in the boiling a curd or caseous matter is partly coagulated, rising to the surface in form of a pellicle or thin skin; if this be removed it is soon succeeded by another, and the effect would go on till the residuum would have a watery appearance, and be incapable of furnishing any more such pellicle. But when milk is very slowly evaporated without boiling, it forms a kind of thick extract of milk, which is called *franchipane;* this, being mixed with sugar, almonds, and orange flowers, constitutes a sweetmeat or custard.

1886. *The quality of cow's milk varies considerably, likewise, according to the manner in which the cows are fed and managed.* In order to possess an abundant supply, it is necessary to have recourse to a constant and plentiful feeding of the animals with rich, luxuriant green food. Certain kinds of food affect the flavour and richness of the milk. Cabbages and turnips impart their peculiar flavour, and injure its quality; and the smallest quantity of wild garlic, if eaten by the cows, is discoverable by the taste. When fed on grains, which is the case frequently in large towns, cows give poor milk.

1887. *Description of the spontaneous changes which milk undergoes.*—When milk is suffered to remain at rest for a short time, it separates into two parts. The *cream* rises to the surface, a yellowish-white, unctuous fluid, with a peculiarly rich taste, containing the greatest part of the butter. After the cream has separated, and is removed, what remains is termed *skimmed milk:* this is much thinner than before, and has a bluish white colour. The milk, now deprived of the cream, if exposed for a day or two to a temperature of from 60° to 70°, becomes a thick coagulum, and during this change it is found that the milk has become sour; an acid has been formed, which has occasioned the milk to separate into two portions, *curd*, called also *caseous matter*, and *whey*. The acid which has been generated and contained in the whey is the *lactic acid*. This coagulum, curd, or caseous matter, however, when produced by *spontaneous* change, is not capable of forming cheese: for this purpose it must be made in a different manner.

SUBSECT. 3.—*Artificial Coagulation of Milk.*

1888. *To produce the kind of coagulum, or curd, necessary to make cheese, some substance*

must be added to the milk for that purpose: the material usually employed in this country is *rennet*, a liquid procured by boiling a portion of the inner coat of the stomach of young ruminating animals, particularly that of the calf; and it is kept salted and cured for this purpose. The effect produced by the rennet is owing to some of the gastric juice of the calf's stomach, which adhered to it, and which is thought to be somewhat of an acid nature. To coagulate, or *turn* the milk, as it is called, into curds and whey, it is heated to about 90° or 100° before the rennet is added. The proper quantity of rennet, and the just degree of heat, can only be learned by a little practice. To make rennet, the inside of the stomach of pigs will also answer, and even the membrane that lines the inside of the gizzard of fowls and turkeys; this last makes the *gallino rennet* of Italy. Many other substances will coagulate or turn milk besides rennet—vinegar and acids of all kinds; and the Dutch employ muriatic acid instead of rennet, which is said to be the cause of the pungent relish for which their cheese is remarkable. Many astringent vegetables also have this effect; likewise alcohol, molasses, gelatin, and many neutral salts. The Jews employ ladies bed straw (*Galium verum*) to coagulate their milk in the making of cheese, the Mosaic law forbidding them to mingle meat with milk; and rennet they consider as meat.

1889. *There is a considerable difference between the curd formed by the spontaneous alteration of milk and that by an artificial process.* That produced by spontaneous coagulation is much less solid, and readily unites with water; what is artificially produced is much more firm, and is insoluble in water. Pure curd is *casein*, very analogous to gum and to albumen, although it differs in some respects from both; by boiling it with an alkali, or lime, it becomes a soluble substance that dries very hard and transparent, like gum, and may be employed as a cement.

1890. *Curd, casein, or caseous matter, the basis of cheese*, is, when fresh, white, insipid, inodorous, and insoluble in water. When just made, a portion of whey adheres to it, but when that is removed by pressure and drying, it becomes *cheese*. The white colour of milk is owing to the curd being intimately mixed up with it.

Subsect. 4.—*Whey.*

1891. *The whey which remains after the separation of the curd in the artificial coagulation of milk by rennet* is a thin fluid, yellowish green, and almost transparent, having an agreeable, sweetish taste, in which respect it differs from spontaneously formed whey, which is always distinctly acid. The whey of the dairy retains a little oily matter, or butter, and some unseparated curd. If it be boiled, a whitish scum rises to the surface, and the liquor becomes turbid; but, upon being set to cool, the matter which rendered it turbid falls down, leaving the liquid quite clear. The scum which rises is somewhat analogous to cream, and is capable of affording butter.

1892. *The principal ingredient of whey is water with lactic acid;* the proportion of curd or casein, butter, and sugar, is very small; hence we should not expect to find whey very nutritive; yet it seems to be well calculated as an article of diet in certain states of the constitution, and in febrile complaints; and, containing always a little acid, it is found to be cooling and refreshing. Besides the saccharine matter and lactic acid, whey contains several saline substances in solution, as a small quantity of muriate of potash, muriate of soda, phosphate of lime and of iron, and sulphate of potash. If whey, by the spontaneous coagulation, be long kept, it becomes very sour; but in this state it is a wholesome and refreshing beverage for labouring people.

1893. *Besides rennet whey*, there are several other varieties of whey used as remedies, as white wine whey, tamarind whey, alum whey, &c., for which see Book XXVI., "Domestic Management of the Sick-room."

1894. *Sugar of milk.*—The sweet taste of new milk and whey is owing to the sugar which they contain. This sugar can be produced in a solid form, and, having some medical reputation on the Continent, it is manufactured in considerable quantity, particularly in Switzerland. It much resembles common refined sugar, but is less white, and has little sweetness to the taste. It is less soluble in water than common sugar, but when dissolved in warm water, it makes a beverage like whey. This sugar is now imported into England, and is sold by many respectable chemists in London, being a good deal used by foreigners, particularly French and Swiss. To prepare it, the whey produced in making cheese is first heated, to separate the butter from it, and is then boiled down to the consistence of sirup; it is poured into earthen pots, and exposed to the sun till it becomes nearly solid. The mass is then put into water, and heated till the sugar is dissolved; and the hot liquor being poured through a linen filter, the insoluble impurities are, for the most part, separated; it is then clarified with the white of egg, and deposites, on cooling, a whitish, crystalline mass, which is the sugar of milk. It does not differ much from grape sugar.

Subsect. 5.—*Cream.*

1895. *When new milk has stood still for six or eight hours, the cream separates* and forms a layer upon the surface. That this may take place in the most expeditious manner, and that the largest quantity of cream may be procured, the milk is put into shallow vessels in which it does not stand above three or four inches deep; and the throwing up the cream proceeds with the greatest regularity when the temperature of the dairy is from 50° to 55°. It is essential that the milk should be kept cool in warm weather, to prevent acidity; but much cold is unfavourable, and when the temperature is so low as 40°, the cream forms with difficulty. The cream is usually removed with a skim-

ming dish made of tin or wood. If butter is to be made from it, it is immediately put into a wooden barrel, in which it is collected until there is a sufficient quantity to be churned.

Cream is a yellowish-white, opaque fluid, smooth and unctuous to the touch, and of an agreeable flavour. It consists of a peculiar oil or butter, curd, and serum or whey. According to Berzelius, it contains in 100 parts, butter, 3.5; curd, or matter of cheese, 3.5; whey, 92.0.

1896. *That cream contains an oil* is evinced by its staining clothes in the manner of oil; and when boiled for some time, a little oil floats upon the surface. The thick animal oil which it contains, the well-known *butter*, is separated only by agitation, as in the common process of *churning*, and the cheesy matter remains blended with the whey in the state of *buttermilk*.

1897. *Cream yields its butter more easily* by standing some days, till it acquires a slightly acid taste: no acid is perceived in the butter, but a little is found in the buttermilk, though not so much as in the cream; hence some acid has disappeared in the churning.

1898. *The consistency of cream increases by exposure to the air.* In three or four days it becomes so thick that the vessel which contains it may be inverted without its being spilt. In eight or ten days more it becomes a soft solid, and its surface becomes tough. It has now no longer the flavour of cream, but has acquired that of cheese. This is the process for making what is termed *cream cheese*.

Subsect. 6.—*Skimmed Milk.*

1899. *This is the milk from which the cream has been removed.* When the cream has been taken off within twelve or fifteen hours from the time of milking, the milk is sweet, and forms a most useful article of food, eaten in a great variety of ways; and it is likewise employed for making cheese and butter, as some of these substances still remain in it. If allowed to remain twenty or thirty hours, it coagulates spontaneously, as above stated, separating into a soft curd and whey, the former of which is extremely wholesome, and, eaten with a little sugar, is excellent. If the whey be kept about three weeks in a warm temperature, it passes into the vinous fermentation by means of the saccharine matter which it contains, and a kind of vinous liquor is prepared from it in some countries of Asia, and from that, again, an ardent spirit is obtained.

1900. *Skimmed milk, analyzed by Berzelius*, affords, in 1000 parts, water, 928.75; gaseous matter, with a trace of butter, 28.0; sugar of milk, 35.0; chloride and phosphate of potash, 1.95; lactic acid, acetate of potash, and a trace of lactate of iron, 6.0; earthy phosphates, 0.30. Other chemists have also found a minute portion of sulphur.

Subsect. 7.—*Milk considered as an Aliment.*

1901. *Milk, considered as an aliment, is of such importance in domestic economy* as to render all the improvements in its production extremely valuable. To enlarge upon the antiquity of its use is unnecessary; it has always been a favourite food in Britain: "Lacte et carne vivunt," says Cæsar in his Commentaries; the English of which is, "the inhabitants subsist upon flesh and milk." It is stated by agricultural writers that the breed of the cow has received great improvement in modern times as regards quantity and quality of the milk which she affords, the form of milch cows, their mode of nourishment, and also in the management of the dairy.

1902. *Although milk in its natural state be a fluid, yet, considered as an aliment, it is both solid and fluid;* for no sooner does it enter the stomach, than it is coagulated by the gastric juice, and separated into curd and whey, the first of these being extremely nutritive.

1903. *Milk, being the natural food of young animals, is universally admitted to be one of the most easily assimilated kinds of nutriment,* more particularly when drank immediately after it is drawn from the udder. When it is coagulated artificially by rennet the curd is less digestible. It appears to occupy a middle rank between animal and vegetable food, and is particularly calculated, not only for young persons, but for all those who require very nourishing aliment. With some constitutions it is apt to become acid; but to counteract this tendency, it may be mixed with soda-water, or have a little magnesia, or a very little soda, put into it.

1904. *To understand the perfection of milk as an aliment,* independently of experience, which has universally declared in its favour, we must consider its chemical composition. Dr. Prout has shown that all our principal alimentary matters may be reduced to three classes: the saccharine, the oleaginous, and the albuminous, represented by sugar, butter, and white of egg. Now, milk consists of all three: the curd, or caseous part, which is chiefly albumen; the butter, chiefly oil; and a portion of sugar. Milk is the only substance prepared by nature so completely perfect as to be a compound of these three principles.

1905. *There is a considerable difference in the milk of various animals.*

1906. *Milk of the human subject* is much thinner than cow's milk, and contains more

saccharine matter. It yields much cream, but no butter can be procured from it by agitation.

1907. *Asses' milk* comes the nearest to human milk of any other; it has, likewise, more saccharine matter than milk from the cow, and is thinner, with a larger proportion of curd. It is considered as the lightest and easiest to digest of any; hence it is a popular remedy in consumption, but is apt to cause diarrhœa in very delicate persons, if taken in too great a quantity. Artificial asses' milk may be prepared by dissolving two ounces of sugar of milk in a pint of skimmed cow's milk.

1908. *Goat's milk* is something thicker and richer than cow's milk. It has a peculiar aroma, contains a great deal of curd, and makes excellent cheese; also affording butter, which is whiter than that from the cow, and is said to keep longer. The milk of the goat is much used in Spain, Italy, and the south of France.

1909. *Ewe's milk* has the appearance of cow's milk. It affords a larger quantity of cream, forming a soft and very fusible butter. Its curd is very soft and unctuous, and when mixed with that of the cow, it gives it a rich appearance. It makes excellent cheese, and in greater quantity than any other milk, but contains the least sugar of any. Ewes were formerly milked generally in this country, but that custom is nearly worn out of use.

1910. *Mare's milk* contains more sugar than that of the ewe, and hence it is much used in Tartary for making a fermented liquor. It contains scarcely any butter.

1911. *Camel's milk* is used only in Africa.

1912. *Buffaloe's milk* is employed in India; it is nearly the same with that of the cow, but rather thinner.

1913. *From no other substance, solid or fluid, can so great a number of distinct kinds of aliment be prepared as from milk*, some forming food, others drink; some of them delicious, and deserving the name of luxuries; all of them wholesome, and some medicinal; indeed, the variety of aliments that seems capable of being produced from milk appears to be quite endless. In every age this must have been a subject for experiment, and every nation has added to the number by the invention of some peculiarly its own. Milk, likewise, enters as an ingredient into an infinity of dishes, for which we must refer to the receipts for cookery. We shall, in this place, enumerate a few preparations used in England that may be considered properly as varieties of prepared milk, and which, though in these times of modern refinement little thought of, formed some of the luxuries among the articles of simple rural fare of our ancestors.

1914. *Curds and whey*, merely new milk coagulated by rennet, and the curds and whey eaten together, with or without sugar.

1915. *Curds and cream.*—Here the whey is removed, and cream substituted; or, if that be too rich, half cream and half milk.

1916. *Costorphin cream*, so named from a village of that name, two miles from Edinburgh, used to be in repute there and in the environs. The milk of three or four days is put, when first drawn, into a wooden vessel, which is submitted to a certain degree of heat, generally by immersion in warm water; this accelerates the separation of the cream. The milk is then drawn off by a hole in the bottom of the vessel; what remains is put into the plunge churn, and, after having been agitated for some time, is sold as Costorphin cream.

1917. *Devonshire cream, called also clotted or clouted cream.*—This is milk brought very gradually to near boiling, but not quite, in shallow tin vessels over a charcoal fire, and kept in that state until the whole of the cream is thrown up, which will be from twelve to twenty-four hours, according to the season. It is essential, in this preparation, that the simmering should not proceed to boiling. The vessel containing it is then taken off the fire, and the cream remains on it till it is cold, when it is skimmed off, and is extremely thick, but, perhaps, not richer than the best common cream, though often thought so. Some, instead of heating the milk over a fire, put it into shallow vessels, which they set to swim upon boiling water in a copper. It is used for eating with fruit, tarts, &c., and is almost peculiar to Devonshire. It does not readily mix with tea or coffee, except beaten up with a little milk. It is now frequently sent up to London quite fresh.

1918. *Dutch clotted cream.*—In Holland they put the fresh-drawn milk into a pan, and stir it with a wooden spoon two or three times a day, to prevent the cream from separating from the milk; when the whole coagulates, the spoon will stand upright in it.

1919. *Tyre* is the name of a preparation used in India to eat with rice. It is made by adding a little buttermilk to warm fresh milk, and letting it stand all night: it is slightly acid.

1920. *Scotch sour cream.*—At night they put skimmed milk into a wooden tub or pail, having a spigot near the bottom. This vessel they put into a tub a little larger, and fill the space between the two with hot water, and let the whole remain all night. In the morning they take out the inner tub, and, gently opening the spigot, allow the thin milk, called *wigg*, to run off, and the remainder will be found converted into a kind of thick *sour cream*. This is eaten with sugar. To make it requires some practice as to the heat of the water.

1921. *The crowdie of Inverness and Ross-shire* is made (according to the celebrated Megg Dods) by "working together well two parts of fresh sweet milk curd and one of fresh butter. It is then pressed into a shape, and turned out, when it will slice well. It is eaten for breakfast. When put up in vessels it will keep for months, and become very high-flavoured, but mellow. The Arabian cheese is made in this way in vats."

1922. *The supply of such a metropolis as London with milk* is, as may be supposed, a very extensive concern. It has been stated that the number of cows kept for this purpose in the environs of London amounts to 12,000, chiefly of the short-horn breed, and great part of the land in the vicinity is devoted to this object; besides which, a great deal of milk and cream is now brought from the distance of five to twenty miles in the country in tin vessels slung in light spring carts; and, as the means of conveyance are improved, the inhabitants of London may expect a more plentiful supply of this necessary article of food, to which we may add, and of a superior quality; for it cannot be expected that milk procured from cows shut up and fed on distilled grains can equal that produced by cows whose health is supported by grass, and living much in the open

air If they are not well fed in winter they often lose their milk. The most considerable London dairies are, one at Islington, belonging to Mr. Rhodes, another to Mr. Laycock, and the so-called Metropolitan Dairy in Edgeware Road. The first is the most complete establishment, containing, on an average, 400 cows. In this the cows are fed on brewers' grains, together with green food and succulent roots, and the whole place is kept extremely clean and well ventilated; but the cows are never allowed to go out. Mr. Laycock suffers his cows to be out some time every day, which, we think, is the best practice. Each cow is allowed a portion of salt. The breed in most esteem with the London cow-keepers is the old Yorkshire stock, or a cross between the Teeswater and the Holderness, as producing the greatest quantity of milk, though it is not of the richest quality. These cows are preferred also, from their great disposition to fatten, for the butcher.

It is publicly stated that it is the practice of some cow-keepers to put by the milk got from the cow at night until the morning, and, when the cream is skimmed off, it is sold as morning's milk. The next morning's milk is treated in a like manner, and sold as evening's milk. The water afterward is added by the retailers. We trust this practice is not universal. It is well known that what is sold for cream is not of first-rate quality; but the sophistications, if any, are too little understood to be easily exposed.

1923. *Adulteration of milk* is very generally complained of, and had, no doubt, been formerly practised to a greater extent than at present, since the means of detection have been pointed out by chemistry. Perhaps the most usual kind of adulteration employed at present is diluting it with water; and it is not easy to detect this fraud except it be carried too far. It is true that the addition of water renders milk of less density or specific gravity; yet, as pure milk varies considerably in this respect, according to the food given to the cattle, and other circumstances, a variation in its weight, except it be very considerable, would not prove that water had been added. M. Barruel, a chemist of Paris, has investigated the adulteration of milk with much care, milk-dealers having been as dishonest in that capital as with us; and he has shown that they increased the specific gravity of watered milk by the addition of another substance, as sugar, which also took off the flat taste given by water, and thus rendered the detection difficult even by the *lactometer*, an instrument for measuring the specific gravity of milk. Water gives to milk a bluish colour; and, to conceal this, it is said that chalk, and also wheat flour, have been added. Chalk is easily found out, because it settles to the bottom after a couple of hours, and then the bluish colour returns; and any person, even of indifferent delicacy of palate, could distinguish the altered taste of the milk. Boiling the flour in the water prevents its settling like chalk; but the existence of any kind of flour or meal may be detected by employing *iodine*, which strikes a blue colour with the starch of the flour. For this purpose, add to the milk or cream suspected some iodine in alcohol, to be had of any respectable chemist; and if there be any flour, arrow-root, starch, or rice, it will be shown by a beautiful blue making its appearance.

1924. *To prevent milk from turning sour in hot weather*, the milkmen of Paris have been in the habit of employing a little subcarbonate of soda or of potash. This, by combining with and neutralizing the acetic acid formed, has the desired effect, and keeps the milk from turning so soon as it otherwise would: the salt that is thus formed, viz., the acetate of soda or of potash, is not at all injurious; and, as pure milk does contain a small quantity of this salt, it is difficult to pronounce upon the addition of any alkali, except there should be some in a free or uncombined state, which does not exist in milk. The addition of a little carbonate of potash will break down the curd that is beginning to form in consequence of souring, or a little calcined magnesia will produce the same effect; but this addition is not unwholesome.

1925. *The possession of a cow affords the most certain method of obtaining pure milk and cream;* and it is scarcely necessary here to remark upon the numerous advantages which a family may derive from it: such as butter churned fresh for breakfast, syllabubs, milk diet, whether in the shape of porridge, arrow-root, and other preparations for children. For the management of a cow, see "Dairy," in a future part of this work.

1926. *An instrument has been employed for measuring the degree of richness of milk very different from the lactometer*, which determines its specific gravity. This instrument ascertains the proportions of cream which any milk will yield, and consists simply of a glass tube a little more than a foot long, with a funnel at the top. The upper two inches of the tube are marked in small divisions, and, when the instrument is filled with milk to the height of a foot, the depth of cream yielded is shown by the marks on the upper part: allowance must, of course, be made for the circumstances under which the cream is formed, and, in comparing two kinds of milk, they should be placed in exactly the same circumstances.

[The first volume ever published on the subject of milk has recently appeared in New-York, by Robert M. Hartley, Esq., an American gentleman, whose philanthropic labours in the service of the great temperance reformation directed his inquiries into this channel, from observing the unnatural methods of producing milk for the supply of large cities, by feeding cows on the refuse of the distillery, and confining them in foul and illy-ventilated stables. The work is fitly entitled, "An Historical, Scientific, and Practical Essay on Milk, as an Article of Human Sustenance," &c., and will be found

to contain an ample and elaborate disquisition on the whole subject, meriting the public attention both in its physical and moral bearings. The editor regrets that want of space forbids even extracts from this valuable work, but to which he refers the curious reader for much original and valuable information on this topic.]

Sect. II.—Butter.

Subsect. 1.—*General Remarks.*

1927. *Butter is, as we have stated, the oil of milk separated by the agitation called churning;* and it differs from common animal fats in containing, besides olein and stearin, the latter of which is quite fluid at 70°, a peculiar matter to which Chevreul has applied the name of *butyrine* or *butyric acid*, to which the agreeable flavour of butter is owing. It is extensively used as food, and in the culinary art, in this and most northern countries of Europe; in the south of Europe it is little employed, olive and other vegetable oils taking its place. In the warm parts of tropical climates butter is always liquid, and it melts at 96°. In India it is made from the milk of the buffalo, and when clarified it is called *ghee*. Burckhardt informs us that the Arabs are extremely fond of this butter, of which they drink a cupful every morning, and use it, besides, in many other ways.

1928. *Beckman, in his "History of Inventions,"* states "that butter was not used either by the Greeks or Romans in cooking; nor was it brought upon their tables at certain meals, as is the custom at present. We do not find it mentioned by Galen and others of his time as food, though they have spoken of it as applicable to other purposes. No notice is taken of it by Apicius; nor is there anything said of it in that respect by the authors who treat of agriculture, though they have given us very particular information with respect to milk, cheese, and oil. This, as has been remarked, may be easily accounted for by the ancients having accustomed themselves to the use of good oil; and butter is very little employed at present in Italy, Spain, Portugal, and the southern parts of France." In England it has been made from time immemorial, though the art of making cheese is said not to have been known to the ancient Britons, and to have been learned from their conquerors.

Subsect. 2.—*General Principles of the Formation of Butter.*

1929. *There are two methods pursued in the manufacture of butter.* In one the cream is separated from the milk, and in that state it is converted into butter by churning, as is the practice about Epping; in the other the whole milk is subjected to the same process, which is the method usually followed in Cheshire. The first method is generally said to give the richest butter, and the latter the largest quantity, though some are of opinion that there is little difference either in quality of quantity.

1930. *The development of an acid appears to be almost essential in the preparation of butter.* To obtain butter readily, either from cream or milk, both these require to be kept for a few days till sourness commences, and in some cases a little warmth is employed to hasten the acidity; but the addition of cream already soured is said to be apt to induce putridity. Butter may, indeed, be made from fresh cream, but it requires much more labour to produce it; and it is said that no butter of good quality can be made from cream that is not more than one day old.

1931. Butter is therefore generally made from cream a little sour, and also from milk allowed to turn thick, or, as it is called in some places, *lapperd*. When very sour cream or milk is churned, the butter-milk, or the milk which remains after the butter has been extracted, is not nearly so sour as the cream or milk had been, and the butter in all cases is perfectly sweet; consequently, the acid which has been evolved has, in a great measure, disappeared during the churning, an effect not easily explained.

1932. *In churning, the heat must be raised* to 50° or 55°, and during the process there is an increase of temperature amounting to 3° or 4°; a little oxygen gas is absorbed, which has been supposed to be by the oil.

1933. *Very rich butter may be made* by using only the latter half of the milking, as it is well known that the first portion of milk drawn from the cow is much less rich than the latter. In the Highlands it is the custom to suffer the calves to suck the first milk, and to use the remainder only for making butter, which by this means they make extremely rich. But this separation could only be made in large dairy farms; and it has been remarked that, in districts where cheese is the principal manufacture, they have the opportunity of making the best butter, contrary to the general opinion; for there they could appropriate the last part of the milkings to the making of butter, and use the first part in making cheese. As it is, while the whole of the cream is taken to make butter, where that is the principal consideration, it cannot be expected that rich cheese can be made of the remainder of the milk.

1934. *The yellowish colour of butter in England is generally in part artificial.* In the summer season, in which the cows are fed on grass, it is seldom requisite to give any artificial colouring to butter, as what it has naturally is sufficient; but in the winter and spring months the natural colour of butter becomes whitish, and often tallowy; the farmers, therefore, to please their customers, use some colouring matter, as arnotto, a

dyeing drug produced from the pulp of the seed-vessel of a shrub (*Bixa orellana*) which grows spontaneously in the West Indies; or the juice of carrots, or the flowers of the marigold; but though these substances are all harmless, the practice of colouring butter should be discouraged, as tending to conceal defects, and to destroy one of the tests of good butter.

SUBSECT. 3.—*Properties of Butter.*

1935. *The taste of butter is peculiar* and very unlike any other fatty substance. It is extremely agreeable when of the best quality, but its flavour depends much upon the food given to the cows: to be good it should not adhere to the knife.

1936. *Butter is not changed by a heat that merely melts it; but if exposed to that of boiling water for a little time,* the butter-milk will rise to the top as a scum, and the curdy matter separates in a coagulated state, and falls to the bottom of the vessel with the whey and water, leaving the butter transparent; it is then called *clarified butter*. What is called *oiling*, in the making of melted butter in cooking, depends upon this principle. If butter is required to be oiled, as it is called, it must be melted, and suffered to stand a little, to separate the sediment, and the clear butter is poured off. Butter-milk, from its bad quality, sometimes runs to oil, in spite of the most vigilant cook. When this happens, it is the practice to put a little cold water to it, and to pour it rapidly backward and forward from the saucepan into a basin, which will partially restore it. But there is an easy method of recovering it completely, by adding to it a little salt of tartar (kept in a close-stopped vial for the purpose); then shaking them together, and the creamy appearance will be reproduced.

1937. *Very much of the goodness of butter depends upon the way in which it has been managed after it is made.* It is pressed and worked to get out the whole of the butter-milk; if the whole is not removed, the butter will infallibly spoil in a short time; and if it is too much worked, it will be tough and gluey. Butter is very apt to become rancid; and it cannot be preserved fresh for many days exposed to the air without the addition of some salt; but it is observed, that the more the butter-milk is extracted, the longer the butter will keep; and, by clarifying, it will keep much longer, even weeks and months, without salt.

The tendency to rancidity in butter is increased by the economical method of warming the milk in order to increase the quantity of cream and butter, and by letting the cream remain too long a time before it is churned. The cream that rises without the aid of warmth, and that is formed into butter while perfectly fresh, will yield the most delicate kind, though with more labour, and which may be preserved for the longest time.

1938. *By the application of salt,* the tendency to rancidity is checked: a small quantity of salt is put to all butter as soon as it is made, for the sake of flavour, even when it is called fresh; and various quantities are added, according to the distance it is to be carried, and the time it is to be kept. In hot weather, fresh butter is generally too soft, even when good: to harden it, it may be kept in one of the apartments connected with the ice-house, if there is one, or it may be placed, for a short time, in a vessel with cold spring-water, into which a little saltpetre or common salt may be dissolved, It may be brought to table in water, but should not remain long in it, as this renders it white and of an unpleasant appearance. When butter cannot be obtained quite fresh every day, or every other day, a few pounds may be sprinkled with a little salt, and pressed into an earthenware pan to preserve it from becoming rancid. This small quantity of salt will not prevent it from being quite fit for the usual purposes of melting, for toast, pastry, or bread and butter.

1939. *Butter, with regard to its dietetic properties,* may be regarded nearly in the light of vegetable oils and animal fats; but it becomes sooner rancid than most other fat oils. When fresh it cannot but be considered as very wholesome; but it should be quite free from rancidity. If slightly salted when it is fresh, its wholesomeness is probably not at all impaired; but should it begin to turn rancid, salting will not correct its unwholesomeness. When salt butter is put into casks, the upper part, next the air, is very apt to become rancid; and this rancidity is also liable to affect the whole cask.

For details of the processes in making butter, see Section "Dairy;" and for the manner of salting it, &c., see "Preservation of Food."

SUBSECT. 4.—*Varieties of Butter used in England.*

1940. *Epping butter* is the kind most esteemed in London, on account of its richness, firmness, and fine colour, and is made entirely from cream. This name was originally given, and properly belongs, to butter made from the milk of cows that feed, during the summer months, in Epping Forest, where the leaves of shrubby plants and wild herbs contribute to improve the flavour: a good deal of butter is still made in that district; but much of that made in other parts of Essex goes under the name of Epping butter. It is made up for market in rolls which weigh a pound each. The fine colour is, in general, natural to it; but some manufacturers, it is said, use the juice of carrots or marigolds, which they mix with the cream before churning.

1941. *Fresh butter is sent up to London*, by wagon, from several other counties, as Suffolk, Oxfordshire, Yorkshire, Devonshire, &c. It is made up into various forms by the London dealers, and sold at different prices, according to the quality. A great deal of excellent butter is made in the rich vales of Buckingham and Oxford for the London market. The farmers there keep a large breed of cows, often in herds of fifty or sixty.

1942. *Cambridge butter* is most esteemed in London next to fresh butter; it is always a little salted, but not cured. This butter is produced from cows that feed one part of the year upon chalk uplands, and during the other part on rich meadows or fens.

1943. *Dorsetshire butter* is nearly similar in quality.

1944. *The mountains of Wales and the Highlands of Scotland*, and the moors, commons, and heaths of England, produce excellent butter under proper management, which, though not equal in quantity, is far superior in quality to that produced from the richest meadows.

1945. *Irish butter* sold in London is necessarily all salted. Some of it is very good, and it is said that the best is sometimes sold in London for Dorset or Cambridgeshire butter, after having been washed and repacked; but most of the Irish butter is of an inferior kind, owing chiefly to the want of attention and cleanliness in the manufacture.

1946. *Dutch butter* has acquired a deserved reputation all over Europe, America, and even India, and is imported in considerable quantities. Its superiority is owing to the fine pasturages of Holland, and in great part to the extreme care and cleanliness with which the butter is manufactured. The best is made in the vicinity of Delft and Leyden. What comes to London is, of course, a little salted: the price is considerably lower than butter of the same quality can be made for in England.

1947. *Kiel and Ostend butter* are well known in London, and, when genuine, are of excellent quality. The salt butter of Holland is said to be superior to that of any other country.

1948. *Whey butter.*—An inferior sort of butter is made from the whey that is separated from the curd in the manufacture of cheese, and is therefore chiefly produced in those counties where cheese is made in large quantities. It is said that in Derbyshire, perhaps, nearly as much butter is made from whey as from cream or from milk. The whey which is pressed out of the cheese is collected, and after twenty-four hours it has thrown up a scum or cream, which is churned for butter.

Subsect. 5.—*Butter-milk.*

949. This is the milk that is left after the butter has been separated by churning. In some districts it is either sold to the poor, or made use of by the farmers' servants; but in large dairies it is most frequently employed as a food for the pigs, and in moistening the bran which is given to the poultry in the farm-yard. When quite fresh, it differs from entire milk, as Parmentier has ascertained, chiefly by the absence of the butter or oily part; but it retains the casein, sugar, and salts of milk. In this state it is very nourishing; and being more easily digested than entire milk, it is sometimes recommended to invalids. As it is extremely cooling, it forms a useful beverage in warm weather, and is often drank by labourers in the fields as refreshing. It is particularly employed in this manner in Scotland. When kept a day or two, it acquires an acescency; but it is proper to notice that the acid of butter-milk does not increase the acescency of the stomach, or occasion flatulence, as vegetable acids commonly do, and it may therefore be safely used by dyspeptic persons. In this state it is refrigerant, and should not be taken when the body is very warm. The butter-milk, where cream has been churned, is particularly rich and agreeable. It can seldom be procured in London; but it is easily made in small quantities by putting some fresh milk into a closed vessel, and using the necessary agitation.

1950. *Thick butter-milk.*—In some places, they put butter-milk into a linen bag, and let the whey drop through; what remains is then much thicker, and, eaten with sugar and cream, is excellent.

Section III.—Cheese.

Subsect. 1.—*Chemical Principles and General Properties.*

1951. *Cheese is the curd formed from milk by artificial coagulation, pressed and dried for use.* In treating of milk, we have stated that curd, called also casein and *caseous matter*, or the basis of cheese, exists in the milk, and not in the cream, and requires only to be separated by coagulation. The coagulation, however, supposes some alteration of the curd. By means of the substance employed to coagulate it, it is rendered insoluble in water. When the curd is freed from the whey, kneaded, and pressed, to expel it entirely, it becomes cheese. This assumes a degree of transparency, and possesses many of the properties of coagulated albumen. If it be well dried, it does not change by exposure to the air; but if it contain moisture, it soon putrefies. It therefore requires some salt to preserve it, and this acts, likewise, as a kind of seasoning.

1952. *All our cheese is coloured more or less*, except that made from skimmed milk. The colouring substances employed are arnotto, turmeric, or marigold, all perfectly harmless, unless they are adulterated; and it is said that arnotto sometimes contains red-lead.

1953. *Cheese requires to be kept* in a dry room where there is a circulation of air, and they should be turned frequently. The room should be kept very clean by sweeping, to prevent the access of mites (*Acarus domesticus*) and other insects. The fly called *Musca putris* deposites its eggs in cheese, which afterward become the maggots called hoppers, or jumpers. Even the common bug will infest cheese if placed near where they resort. The production of mites may be checked by pouring spirits into the affected parts.

1954. *Some prefer cheese when it begins to change blue*, or begins to putrefy; and means are sometimes taken to produce this change, or render it *ripe*, as it is called. This is effected by putting the cheese into a damp place, and turning them from time to time. By this they absorb water, increase in bulk, become unctuous and soft, and begin to give out a peculiar smell, which increases until it becomes ammoniacal. Some gourmands, instead of allowing them to absorb water, saturate them with port wine or strong ale. The blue mould that appears upon the surface of cheese that has been cut and kept shut up too close is a species of fungus, or minute vegetable, and may be distinctly seen when examined by a magnifying glass; but the blue mould which appears in the interior of cheese is a substance not well understood.

1955. *Cheese, when analyzed*, is found to consist of carbon, 59·781; hydrogen, 7·429; oxygen, 11·409; nitrogen, 21·381. From its containing so large a quantity of nitrogen, it must be considered as a highly animalized substance.

1956. *As diet* for persons in sound health, and who have plenty of exercise, it appears to be salutary; but to those of weak constitutions, and valetudinarians, it is sometimes found difficult of digestion, particularly what is made of skimmed milk and much dried. Vauquelin has shown that cheese contains ammonia, particularly old cheese, and the odour of ammonia is very evident in what is decayed. It is probably the presence of this alkali that causes old cheese to prevent the injurious effects of acid fruits, as well as to render their taste milder. The fatness of cheese cannot be ascertained by its appearance: toasting shows this quality best. Some cheese, apparently fat, dry up with the heat, while some apparently dry cheese, when toasted, become fat. Cheese requires a certain time to acquire its proper flavour. When too new, it is insipid and wasteful.

1957. *Cheese varies in quality and richness* according to the materials of which it is made. It is made, 1, of entire milk, as in Cheshire; 2, of milk and cream, as at Stilton; 3, of new milk mixed with skimmed milk, as in Gloucestershire; 4, of skimmed milk only, as in Suffolk, Holland, and Italy.

When new milk or cream is employed partially, there is a good deal of fat or butter in the cheese, as in the Cheshire, Stilton, and Gloucester, whereas skimmed-milk cheese contains very little fat; but it is admitted by good judges that the quality of cheese depends as much, at least, upon the mode of manufacture as on the materials. Some of the most agreeably-tasted cheese is made of skimmed milk, as the Parmesan, and some of the Dutch cheese. Rich or fat cheese is prone to decomposition, and is apt to collect mites or maggots: hence the poor cheeses, such as the Dutch, are preferred for carrying to sea, from their keeping better. Braconnot has shown that the flavour of cheese depends upon a peculiar principle, which he has called *caseic acid*. For the process of making cheese, see Book XXV., "Dairy."

Subsect. 2.—*Varieties of Cheese.*

The principal varieties of cheese used in England are the following:

1958. *Cheshire cheese.*—This cheese is famous all over Europe for its rich quality and fine, piquant flavour. It is made of entire new milk, the cream not being taken off. The cheeses are generally of very large size, usually about sixty pounds' weight, and some have been made of one, or even two hundred weight. Each cheese is usually made of the produce of one day's milking from herds of from 100 to 200 cows, who feed in rich pastures on some of the finest land in England. Their excellence must be attributed to the goodness of the milk, their size and age, and the skill employed in the manufacture. The colour is not entirely natural; but a yellow tint is given by *arnotto*, marigolds, or carrots. It is said that some increase the richness and mellowness of the cheese by adding beef suet, or any other wholesome and sweet fat well clarified, which is poured into and mixed with the curd.

1959. *Gloucester cheese* is much milder in its taste than the Cheshire. There are two kinds of Gloucester cheese, single and double. *Single Gloucester* is made of skimmed milk, or of the milk deprived of half the cream; of course it is not very rich, but is often of good flavour. *Double Gloucester* is a cheese that pleases almost every palate: it is made of the whole milk and cream, and is a fat cheese, usually the kind employed for toasting, though the single often toasts very well. These cheeses are made of various sizes, the single generally eight to the cwt., and very thin, and the double four to the cwt., and at least twice as thick. As the two kinds sometimes resemble each other considerably, some honest farmers stamp a figure of a heart upon the single Gloucester, to distinguish it from the double. The true characteristics of Gloucester cheese con-

sist in its great richness, together with the mildness of its flavour, and that smooth, waxy texture which makes it cut, even in thin slices, without crumbling, as Cheshire cheese is apt to do. Its oily matter is retained in toasting, by softening without being burned.

1960. *Stilton cheese.*—This, from its peculiar richness and flavour, has been called the Parmesan of England. Its name is derived from having been first made at Stilton in Leicestershire, though it is now manufactured very generally throughout the counties of Cambridge, Huntingdon, Rutland, and Northampton. It is made by adding the cream of one day to the entire milk of the next. The cheeses are all of a small size, from six to eight pounds' weight, and are of a cylindrical form, made in a deep vat, and are not considered to be sufficiently mellow until they are two years old, nor ripe until they exhibit spots of blue in the interior, marking the commencement of decay. It is said that some keep them in warm, damp cellars to accelerate the ripening. The blue part is of a peculiar nature, different, it is said, from the common blue mould of cheese. The decay should not be advanced beyond a certain point. A variety of Stilton, but not so rich, or of so fine a flavour as the last, is made in a net, and of the form of a pine cone, the net impressing lines on its surface.

1961. *Cottenham cheese*, made near a town of that name in Cambridgeshire, is a thicker kind of cream cheese than Stilton. Its superior delicacy and flavour are attributed to the fragrant herbage on the commons where the cows are pastured.

1962. *Sage cheese*, called also green cheese, is made chiefly in the vales of Gloucester and Wiltshire, by colouring some curd with bruised sage, marigold leaves, and parsley, and mixing this with some uncoloured curd; the whole is then made into a cheese, which, of course, exhibits a mottled appearance.

Among the Romans it was a practice to flavour cheese with thyme and other sweet herbs; and this custom was continued during the middle ages. We are told that the Emperor Charlemagne, arriving at a bishop's palace on a fast day, could get nothing but bread and cheese. The prelate, observing the king picking out with his knife small specks, which he mistook for impurities in the cheese, informed his guest that they were parsley seeds. The monarch tasted them, and liked them so much that he requested the prelate to send him an annual supply of cheese prepared in this manner.

1963. *Chedder cheese* is not exclusively made at the village of Chedder, in the Mendip Hills, Somersetshire. A great deal of the same kind is also made round Bridgewater, and in the marshes round Glastonbury. The cheese is peculiar, much resembling Parmesan; it has a very agreeable taste and flavour, and has a spongy appearance, the eyes being filled with a limpid and rich, but not rancid oil. The cheeses are generally large. But little of the prime Chedder cheese is made, that generally sold for it not being genuine, and is inferior.

1964. *Brickbat cheese.*—There is nothing remarkable in this except its form. It is made by turning with rennet a mixture of cream and new milk. The curd is put into a wooden vessel the shape of a brick, and is then pressed and dried in the usual way. It is best made in September, and is ready in six months.

1965. *Dunlop cheese* is famous in Scotland: it is so called from the Parish of Dunlop, in Ayrshire, where it was first or best made, and where the pastures are very rich; but it is now manufactured in other parts of Ayrshire. The best is made entirely from new milk, and it has a peculiarly mild and rich taste; but there is nothing remarkable in the manner of making it.

In some parts of England they never churn the milk, but only the cream; consequently they make little butter-milk, because the servants will not eat this, though they have no objection to skimmed milk. In Scotland and Ireland, on the contrary, they churn all the milk, and have, of course, much butter-milk, which is much relished there.

In the Highlands of Scotland they make a cheese for the table of a very high *gout*, an almost Tartarian preparation, by allowing the milk to become sour, and to coagulate of itself, which gives a flavour even more pungent than that of goat's-milk cheese.

1966. What is called in London *new cheese* is made chiefly in Lincolnshire, and is either made all of cream, or, like the Stilton, by adding the cream of one day's milking to the milk that comes immediately from the cow: they are extremely thin, and are compressed gently two or three times, turned for a few days, and then sent to be disposed of to be eaten new with radishes, salad, &c. It may be made in the following manner: Warm some cream, add rennet in the proportion of a spoonful to a pint, or more if necessary. Put the curd into a sieve, having a cloth at the bottom; when it has remained twenty-four hours, transfer it to a cheese vat, and cover it with a wet cloth and board; in about two hours it may be used.

1967. *Skimmed-milk cheese.*—Cheese made from the curd of skimmed milk, when all the cream has been separated, has in it no butyraceous matter, but is the caseous substance in a pure state, resembling very nearly white of eggs or albumen, or, perhaps, more nearly the gluten of wheat. This cheese from skimmed milk only is made in those districts of England where butter is the chief object of the dairy-man, as in Essex and Suffolk. What is made in England of this kind has scarcely any flavour, and dries almost as hard as horn, but is as digestible as the softer cheese, though not very palatable. It is, however, useful as part of ship stores, being less liable to spoil on a sea voyage than richer cheese, particularly in a warm climate. On the subjec

of skimmed-milk cheese Dr. Anderson, celebrated for his writings on agriculture, observes that it is an erroneous idea to suppose that the agreeable taste of cheese depends solely upon the quantity of oily or fat matter it may contain. Parmesan cheese is made of skimmed milk; so are the Dutch cheeses, which many consider as very pleasant tasted. He has seen cheese made of skimmed milk that ate exactly like the finest cream cheese, and he considers that what is called richness in cheese depends as much upon the particular mode in which they are manufactured as upon the materials of which the cheese consists. In confirmation of this opinion, he remarks that, though the taste of double Gloucester differs so much from Cheshire cheese, yet they are both made from the same kind of milk.

1968. *Parmesan cheese.*—This most celebrated of all cheese is made in the duchy of Parma and Piacenza, and in various parts of Lombardy: at present the district of Lodi is in high repute for it. It was formerly supposed to be made from goats' milk; but it is made merely of skimmed cows' milk, and the high flavour which it has is supposed by some to be owing to the rich herbage of the meadows of the Po, where the cows are pastured, and by others solely to the process by which it is manufactured, a particular account of which may be seen in Cadell's "Journey in Italy, 1818." Half the milk has stood sixteen or seventeen hours, and the other half has stood only six. The milk is heated and coagulated in a caldron, and, without being taken out of the caldron, the curd is broken very small by an implement consisting of a stick with cross wires; it is again heated, or, rather, scalded, till the curd, now a deposition from the whey, has attained a considerable degree of firmness; it is then taken out, drained, salted, and pressed, and in forty days it is fit to put into the cheese loft. The best Parmesan is kept for three or four years, and none is carried to market till it is at least six months old. Another account of the manner of making it is to be found in the seventh volume of the Bath Society's papers, and in the second volume of Mr. Arthur Young's "Travels in France."

1969. *Dutch cheese.*—In Holland they coagulate their milk with muriatic acid instead of rennet, which occasions that pungent taste peculiar to this cheese, and preserves it from mites. The *Gonda* is most celebrated, which is made with extraordinary care. A detailed description of the mode of making it is published in the *Jour. Agri. des Pays Bas*, and is quoted in the excellent work by Margaret Dodds. The best Dutch cheese is made in the environs of Leyden, at Eidam and Friezland, where also a very large quantity is manufactured for England, of skimmed milk, chiefly for sea stores. In the Texel they make cheese from ewes' milk: a good deal of Dutch cheese of a round form comes now to London; it is of a low price, and frequently of very good quality.

1970. *Swiss cheese.*—Switzerland has been long celebrated for its cheese: several varieties of cheese are produced there, and though made of skimmed milk, or partially skimmed milk, yet are they remarkable for their fine flavour, which is partly owing to the herbage of the mountain pastures. That denominated from *Gruyère*, a bailiwick in the canton of Fribourg, is best known in England. This is flavoured by the dried herb of *Melilotos officinalis* in powder. The cheeses weigh from forty to sixty pounds each, and require to be kept in a damp place, and washed frequently with white wine to preserve it from the depredations of insects. Until of late, the manufacture of this cheese was limited to a few wealthy persons: as it is necessary for its quality that the cheese should be very large, and that the milk should be coagulated on the day it was taken from the cow, it was only by keeping a large number of cows that the manufacture could be carried on, and the owner of a few cows only was unable to succeed. At present, however, it appears that cheese dairies have been established by the poor peasantry joining together, and thus competing with the more wealthy. Another excellent cheese is made at *Neufchatel*. The *Schabziegar* cheese is made by the mountaineers of the canton of Glarus. It has a marbled appearance and aromatic flavour, from the bruised leaves of the melilot. The milk is exposed to the temperature of 46° for five or six days, when the cream is completely formed, and is taken off. The skimmed milk is coagulated by sour milk, and not by rennet, and the curd thus obtained is pressed strongly in bags, and when sufficiently pressed and dried, it is ground to powder, salted, and mixed with the bruised flowers or seeds of the Melilotos officinalis, and afterward again pressed into cheese. The entire separation of the cream, or unctuous part of the milk, is essential. Some Swiss cheese is also manufactured from a mixture of ewe-milk with that of the cow.

1971. *Westphalia cheese* is a skimmed-milk cheese, and is a remarkable instance of how much the quality of cheese depends upon the manufacture. It is described by some as being preferable to the Dutch, Swiss, and even Parmesan cheese. The cream is allowed to remain till the milk beneath is sub-acid; it is then removed, and the milk placed near a fire to coagulate. The whey is next expressed from the curd, which is dried and crumbled between the hands. It remains for several days until the putrid fermentation commences; but this is stopped by kneading it into balls with carroways, salt, butter, pounded pepper, and cloves. Sometimes these balls, or little cheeses, are hung up in the smoke of a wood fire.

1972. *Cheese from milk and potatoes* is manufactured in Thuringia and Saxony. The best potatoes are half dressed in steam, peeled, and reduced to a pulp. Five pounds of this are mixed with from one to ten pounds of sweet curd, and kneaded together, some salt being added; after lying for a few days, this is again kneaded, and then pressed into little baskets, where the superfluous moisture drains off; the cheese are then formed into balls and dried in the shade. These cheeses keep well in the dry, and their quality improves with age, with the advantage that they generate no vermin; their taste is said to exceed the best cheese made in Holland.

1973. *Cream cheese*, although so called, is not properly cheese, but is nothing more than cream dried sufficiently to be cut with a knife. To make it, a quantity of good

sweet cream is put into a cheese vat, with green rushes sewed together on purpose, at the bottom of the vat, which must have a sufficient number of holes to let the whey which drains off pass freely away. On the top of this cheese are likewise laid rushes or long grass of the Indian corn, in the same manner as at the bottom, in order to allow it to be turned without being handled. It is usual to make these cheeses from one inch to one inch and a half in thickness. The thinner they are made, the sooner they are ready. It is kept in a warm place to sweat and ripen; but extremes of heat or cold are injurious, and some judgment must be used in managing it.

CHAPTER V.

BIRDS.

SECT. I.—INTRODUCTORY OBSERVATIONS.

1974. *The feathered tribe of animals*, or *birds*, furnish a considerable and varied supply of sustenance to man; and they possess this quality in common with quadrupeds, that none of them are absolutely deleterious when used as food, although their properties in this respect vary considerably. Like quadrupeds, also, some birds which have been found the fittest for the table have been long domesticated, while others remain always wild. Birds of prey are never eaten among us, their flesh being coarse, tough, and ill-flavoured.

1975. *Those which serve us as food may be divided into such* as are domesticated, as the common fowl, turkey, duck, and goose; wild birds, usually termed game, as the pheasant, partridge, grouse, woodcock, &c.; and some other wild birds, that are not considered as game, such as lark, pigeon, &c.

Of birds, both domestic and wild, some are white-fleshed, as the common fowl, turkey, and pheasant; others have a dark-coloured flesh, as the duck, goose, and pigeon, also grouse, blackcock, &c.

Game, in this country, is usually considered as a luxury rather than a general article of food; and it is frequently kept for some time, until it has acquired a peculiar odour, called *fumet*, and a certain slightly aromatic bitter taste.

Of aquatic birds, both swimmers and waders, many are very delicate, though in general they are disposed to become fat, and some have a rank, fishy taste.

1976. *Not only the fattening, but the flavour of birds* is very much influenced by the nature of their food. Those which feed upon grains and vegetables, as the common fowl, turkey, and pheasant, are the most delicate, and have the whitest flesh. Those which live partly on animal and partly on vegetable food, as ducks and geese, are brown-fleshed, and higher flavoured; and those which, being aquatic, live wholly on fish, have a taste savouring of the creatures they feed upon; it is remarked that the same bird may be made to acquire, in a certain degree, a peculiar flavour by managing its food accordingly. If permitted to go at large, with plenty of food, and under favourable circumstances, as in the case of common fowl in a farm-yard, they often get sufficiently fat; but domestic fowls are generally fattened for the market, and sometimes not in the way best calculated to promote their health, and, consequently, wholesomeness as food. Some wild birds are migratory, and can only be had while they remain with us; before the use of gunpowder these were caught by hawks trained for the purpose, a mode of killing calculated to render the flesh more tender; at present they are shot, hawking having gone out of use. Some small birds, as larks, are caught in nets and traps.

1977. *The fat of birds is not dispersed through the muscles or marbled, as it is in quadrupeds*; and different parts of the same bird differ very much in flavour and other properties. Every one knows how much whiter the pectoral muscles which move the wings are, when cooked, than those which move the legs; but the flesh of the latter is more juicy, and, when tender, from being young and well dressed, is by many preferred. The legs of the snipe and the woodcock are always preferred to the breast. The legs of birds are more apt to get tough and stringy when old, particularly the tendons and ligaments; hence the greater difficulty in carving them. The flesh of birds, particularly poultry, is extremely nutritious and easy of digestion; therefore very fit for valetudinarians.

1978. *The internal organs or viscera of birds* are partly eaten; of these the gizzard is digested slowly, and is not proper for dyspeptic persons. The intestines of the woodcock, called the *trail*, when dressed is considered by epicures as a delicate morsel. The liver has a peculiar flavour, from the bile contained in it: by some it is relished, and disliked by others. The livers of geese fattened and enormously enlarged, so much the fashion in some parts of the Continent, are really in a state of disease; and Dr. Prout remarks that it can scarcely be considered as free from danger to eat them.

1979. *The term poultry* is applied to all kinds of domestic fowls brought up in a farm-yard. In Britain, where much butcher's meat is consumed, these are generally esteemed a luxury, and, consequently, are not reared in such considerable quantities as in

France, Egypt, and some other countries, where it is used more as a common article of food. In France, poultry forms an important part of the live stock of the farmer, and it has been said of that country that the poultry-yards supply a much greater quantity of food to the gentleman, the wealthy tradesman, and the substantial farmer, than the shambles. It is well known that in Egypt it has been, from time immemorial, a considerable branch of rural economy to raise domestic poultry for sale, hatched in ovens, by artificial heat. The warmer climates are far more favourable than ours for the purpose of raising poultry; and the same remark necessarily holds with respect to this country, where the warmest and driest soils are best adapted to this production, more especially of chickens and turkeys.

It is conceived that the consolidations of farms, among other consequences, has diminished the quantity of poultry, and, consequently, enhanced the price. Though the gentleman, the yeoman, and the capital rack-renter may sometimes rear enough for the supply of their own table, yet it is not an object with them to produce a supply for the public, and the business of breeding poultry for the market is either left to the cottager, whose means and opportunities are too limited, or to the little tradesmen and farmers. When markets are too distant for the cottagers, their poultry is purchased by the higglers, who carry it to the large towns for sale.

1980. *Hatching chickens by artificial heat* may be mentioned as one of the modes of increasing food, perhaps deserving of attention. This method, we are informed by Diodorus and Aristotle, was practised from time immemorial by the Egyptians, and is still used in that country to a considerable extent. This art is practised very successfully by the inhabitants of a village named Bermé, and by those who live at a small distance from it. Towards the beginning of autumn, the persons who follow it as a trade spread themselves into various parts of the country, and each one offers his services in managing an oven. The ovens are of different sizes, but generally hold from 40,000 to 80,000 eggs. Each Bermean engages to deliver two thirds as many chickens as he receives eggs; and as many of the remaining third as he hatches are his own property. From a newspaper, published by the Egyptian government, it appears that upward of seventeen millions of chickens are annually hatched in this manner in Egypt; and the fowls, when grown up, are not inferior to those produced by incubation.

The members of the French Academy, in the early and middle part of the last century, in consequence of the reports of travellers, made experiments on this subject, under the direction of Reaumur; the trials succeeded, and the details of the methods employed were published in a volume, which was translated into English in 1750. These experiments were repeated by various individuals, not only in France, but at Florence, and in Poland. M. Bonnemain, a physician of Paris, succeeded, in 1777, in hatching chickens in an apparatus heated by hot water; and it is said that chickens produced in this way supplied the table of Louis XIV.

1981. *We give the method used by M. Bonnemain*, which is interesting, because it appears to have been the first example of the mode of producing a very uniform degree of temperature, by means of hot water, now extensively employed in warming buildings.

A box in a wooden building was constructed for hatching the eggs, provided with many shelves in the inside, in which the eggs were placed;* pipes proceeding from a boiler passed between all the shelves, and the heat was kept up by the circulation of hot water through them. The fire being lighted, the temperature is raised till the heat is obtained in the box which is necessary for incubation, which is about that of the human body, or 98°; and this is ascertained by a thermometer placed in the box. It is convenient not to cover, on the first day, more than the twentieth part of the superfices of the shelves, and to add every day, for twenty days, an equal quantity of eggs, so that on the twenty-first day the quantity of eggs first placed will be for the greater part hatched; and we may thus obtain every day nearly the same number of chickens; but this, nevertheless, may be occasionally regulated by the particular season of the year. During the first days of incubation, whether natural or artificial, the small portion of water contained within the substance of the egg evaporates through the pores in its shell; this is replaced by an equal portion of air, which is necessary to support the respiration of the chick; but as the atmospheric air which surrounds the eggs in the box at that degree of temperature is completely dry, or but little humid, so the chick would greatly suffer, or finally perish from this kind of desiccation, were not some remedy provided; and thus, in order that the eggs may be better hatched in the dry seasons, the hens cover them with the earth on the floor of the place where they sit. In artificial incubation, to keep the air in the stove constantly humid, they place it in flat vessels, such as plates, filled with water. When the chickens are hatched, they are removed from the stove, and carried to another box called the cage, where they are fed with millet, and nestle under a sheep's skin with wool in it suspended over them; this is called an artificial mother, and is to supply the place of the shelter afforded by the hen. They also separate, by means of partitions in the cage, the chickens as they are hatched each day, in order to modify their nourishment agreeably to their age. The heat in the water, and, consequently, in the box, is very accurately regulated by means of an apparatus very ingenious, but too complicated to describe in this place. The complete details may be seen in Gill's "Technological Repository," Feb., 1828, p. 70.

1982. *Lately, the public has been amused by the exhibition, in London, of a mode very similar of performing the same process*, which appears to be completely successful. A large box is divided by shelves in the manner of the hot closets that are heated by steam; each division, into which the eggs are laid in flannel, is surrounded on the top, bottom, and sides by steam, and kept exactly to the same temperature. By doors opening into the several divisions, the eggs are perfectly accessible, but must be turned every twenty-four hours. On the eighteenth day the audible sign of life is apparent, by the faint piping of the chick being heard; and on the twentieth or twenty-first day the young creature liberates itself from its prison by breaking the shell in a curious manner with its bill, and by the muscular exertions of its limbs emerges into a new existence. It is curious to see the little animals run about and peck their food, which is ground biscuit, and hard eggs chopped, almost immediately after their birth. These are then put into a low glass case, the floor of which is covered

* A wood-cut of Bonnemain's apparatus is inserted in the section "On Warming Buildings by Hot Water."

with gravel; and in a few days they acquire strength enough to be removed into a larger space on the floor, also covered with gravel. The food is scattered among the gravel, and they feed themselves from the time of leaving the eggs. Upon the whole, the process of hatching in this manner appears to be very simple; but whether it would be profitable, as a speculation, to breed up chickens thus for the market in this climate, where the difficulties will be found much greater than in Egypt, remains to be ascertained by an experiment, which, however, deserves to be made. In New-York, where the climate is severe, they contrive, by means of artificial heat, to make the hens lay all the winter, and likewise breed up chickens.

1983. *Artificial incubation is practised among the Chinese.* Whole swarms of ducks are bred in barges surrounded with projecting stages, covered with coops for the reception of these birds, which are taught by the sound of the whistle to jump into the rivers and canals in search of food, and by another call to return to their lodgings. They are usually hatched by placing their eggs, as the ancient Egyptians were wont to do, in small ovens or sand-baths, in order that the same female may continue to lay eggs throughout the year; which would not be the case if she had a young brood to attend. The ducks, when killed, are usually split open, salted, and dried in the sun, in which state they afford an excellent relish to rice or other vegetables.

1984. *In the following description of birds employed as food,* we have not considered it as essential to arrange them according to the classification usually adopted in treating of their natural history, but rather according to their relative importance as food. They are, however, also grouped according to their natural classes, as nearly as is consistent with our view.

Sect. II.—common or domestic fowl (*Gallus Domesticus*, Linn.).

1985. The tame or domestic fowl, so common with us, is supposed to be derived from some of the wild species which are found in great plenty in the forests of India; but they have been domesticated from time immemorial.

1986. Like other domesticated animals, they have been divided into different breeds, of which those most esteemed here are, the common dunghill or barn-door fowl, often white, but also of every variety of colour; the Dorking; the black or Poland; the Bantam; the game fowl; and the Chittagong or Malay. Besides these, there are several others more rare.

1987. *The common dunghill fowl,* known also by the name of the barn-door, white, or English breed, is of a middle size, and will become fat upon the usual run of the farm-yard, where they thrive upon the offals of the stable and other refuse, with perhaps some small regular daily feeds. At threshing-time they become particularly fat, and both from the full allowance of corn and the constant health in which they are kept, by living in a natural state, and having the full enjoyment of air and exercise, they become the most delicate and high-flavoured of all the varieties.

1988. *Dorking fowls* take their name from Dorking in Surrey, celebrated for breeding them in great plenty and perfection. They are a large and handsome variety, and the flesh is fine, but inclined to a yellowish shade. The lay large eggs, and the capons are generally made from this breed, which has frequently five toes.

1989. *The Poland breed* is black with white tops. Their form is plump; they fatten well, and in quality they are similar to the Dorking, or, rather, superior. They lay abundance of large eggs.

1990. *The every-day, or Dutch fowls,* are smaller than the above, but have still longer plumes, so large, indeed, that their feathers should be cropped occasionally, or they will get into their eyes and blind them. They are called "everlasting layers" from the abundance of their eggs.

1991. *The bantam* is an extremely small variety, originally from India, remarkable on account of its grotesque figure, being generally feathered to the toes. From its size and delicacy, they are very convenient, as they may sometimes stand in the place of chickens, when these are not to be had; and they are particularly useful for sitting upon the eggs of partridges and pheasants, being good nurses as well as layers.

1992. *The game fowls* are rather small; but the flesh is beautifully white, and superior to that of any other variety in richness and flavour. The eggs are small and very delicate; but the chickens are difficult to rear, from their pugnacity of disposition, for which this breed is so remarkable. Great cruelty has been exercised with this animal in making them fight; but it is to be hoped that such unmanly sports will disappear.

1993. *The Chittagong* is an Indian breed, and the largest variety of the species; colour, striped. Their flesh is coarse, dark, and best calculated for soup. They are good layers, but not steady sitters.

1994. *The term chicken* is applied to the young female till they are four months old; after which they are *pullets* till they begin to lay, when they are *hens*. The male is a *chicken* till he is three months old: he is then a *cock-bird* till twelve months old, when he is a *cock*. When deprived of the faculty of procreation, he becomes a *capon;* and a female in the same condition is a *hen-capon*.

1995. *Though in general fowls, when in health, will become sufficiently fat by having plenty of food, with air and exercise,* yet they are commonly fattened for the London market. The means usually employed are, to keep them in confinement, with abundance of food, and little light; so that, in fact, they have nothing to do but to eat. It is a common practice with some housewives to coop their barn-door fowls for a week or two, under the notion of improving them for the table, and increasing their fat: a practice which, however, seldom succeeds, since the fowls generally pine for their loss of liberty; and,

slighting their food, lose instead of gaining additional flesh. Such a period is, in fact, too short for them to become accustomed to confinement.

1996. *Fowls are generally fattened by being confined in coops for several weeks.* The privation of light, by inclining fowls to a constant state of repose, except when moved by the appetite for food, promotes and accelerates obesity; but such a state, observes Mr. Mowbray, obtained in this way, cannot be a state of health, nor can the flesh of animals so fed equal, in flavour, nutriment, and salubrity, that of the same species fed in a more natural way. Economy and market interest may, perhaps, be best answered by the place of darkness and close confinement; but a feeder for his own table, of delicate taste, and ambitious of furnishing his board with the choicest and most salubrious viands, will declare for the natural mode of feeding; and in that view, a feeding-yard, gravelled and turfed, a room being open all day for the fowls to retire in at pleasure, will have a decided preference, as the nearest approach to the barn-door system.

1997. *Some places are remarkable for the feeding of poultry:* North Chapel and Kinsford, in Sussex, are mentioned by Rev. Arthur Young. Barley and wheat meal are the bases or chief ingredients in all fattening mixtures for chickens and fowls; but in Sussex the food given them is ground oats made into gruel, mixed with hog's grease, sugar, pot-liquor, and milk; or ground oats, treacle and suet, sheeps' plucks, &c. With these mixtures they are *crammed*, and kept in a coop for a fortnight, when they become fat, and are sold to the higglers. Some of these fowls, when full grown, have been known to weigh seven pounds and more. Oakingham in Berks is another place famous for fattening fowls. The method employed is nearly the same as has been just mentioned. If kept too long upon this food, fever is induced by a constant state of repletion, which renders the flesh red, and frequently kills them. It appears utterly contrary to reason, that fowls fed upon such greasy and impure mixtures can produce flesh and fat so firm, delicate, and wholesome as those which are fattened upon more simple and substantial food. In the system of cramming there are sometimes cruel practices, with the mention of which we do not wish to stain our pages. It is remarked by the best judges that, where artificial feeding is required, the best method is to have feeding-houses constructed, warm and airy, with dry floors covered with sand and gravel, and kept very clean; food should be given in abundance, but of a natural and simple kind, made of grain, oatmeal, milk, boiled potatoes, bread, and sometimes mixed with a little dripping, not more than twice a day, so as to preserve perfect health. The counties of England most productive of poultry are Norfolk, Surrey, Sussex, Herts, Devon, and Somerset. Spring is the best season for breeding chickens; but the attempt to rear winter chickens in this climate seldom succeeds. The spring pullets, properly fed, are particularly fine.

1998. *In the opinion of physicians, both ancient and modern, the flesh of the chicken*, at three months old, is the most delicate and easy to digest of all other animal food; thence it is the best adapted for the stomach of invalids, or the constitutionally weak. Age makes a striking difference in the flesh of fowls; after twelve months it becomes tougher and more insoluble; the male, indeed, at that age, is only fit for making soup, while the pullet is still excellent, although a more substantial viand than the chicken. While young the cock and hen are equally delicate. The capon, when not made excessively fat, has been esteemed one of the greatest delicacies, preserving the flavour and delicacy of the chicken with the juicy maturity of age.

The mode of killing, by drawing or stretching the neck, when unskilfully performed, it may be proper to mention, is productive of great and unnecessary suffering to the animal: sufficient force should be used to break the spinal cord, otherwise death does not ensue immediately.

The common fowl belongs to the order Gallinæ, or gallinaceous birds, which also comprehends the turkey, pheasant, partridge, bustard, peacock, and quail.

Section III.—guinea fowl (*Meleagris Numidia*, Linn.).

1999. This bird is so named because first brought from Africa, where only it is wild in great abundance. In a state of nature these birds are gregarious, and are seen in flocks of two or three hundred: they delight in marshy places, but always perch at night upon high trees, or in dry situations. They are about the size of the common hen, but stand higher on the legs. Though domesticated, they retain much of their wild nature, and are apt to wander. They lay very abundantly, and their eggs are excellent. They are not so white in the flesh as the common fowl, but more inclined to the colour of the pheasant; and, like it, the taste is savoury, and it is easy of digestion; by many they are considered as a good sustitute for the pheasant. They are excellent for the table, having somewhat of the same flavour, and they are in season when game is going out.

Section IV.—turkey (*Meleagris Gallipavo*, Linn.).

2000. This excellent bird is a native of America only. It was introduced into Europe from Mexico, and imported into England from Spain about 1524, in the reign of Henry VIII., since which time they have been successfully bred here, but were so rare in France, that the first which was eaten in that kingdom appeared at the nuptial feast of Charles IX., in 1570.

2001. *The wild turkey* abounds at present in some parts of America, but has become more scarce since the country has been cleared of wood. In March they get so fat that they cannot fly more than three or four hundred yards, and are soon run down by a horseman. In the unfrequented parts bordering on the Mississippi, they may be shot with a pistol. In this state they are black, or a beautiful bronze and green; but domestication produces considerable variety in their colour. The usual weight of the wild turkey is about thirty pounds: it frequents swamps, but repairs to the woods to roost, and feeds upon berries, acorns, and other wild fruit, as well as herbs. Their flesh is excellent.

2002. *There are three varieties in this country:* the black, the copper or speckled, and the white. The black is the nearest to the natural stock, and is larger and more hardy. These abound in Norfolk, and are esteemed superior to others; they often weigh fifteen pounds, particularly when crossed by the large Virginian. It is said that their superiority is chiefly owing to the dryness of the soil in that district; they are brought up by every little farmer in the county, which furnishes the largest supply to the London market; but they do much mischief to the field crops, which prevents many farmers in other parts from keeping them. The white variety is rare here, though common in France.

2003. *The flesh of the turkey* is white, tender, delicate, nutritive, and restorative, of excellent flavour, and more dense and substantial than that of the chicken. Age produces a similar effect as in the chicken: when old, it is good for little except stewing.

The usual mode of killing this bird is tedious: it is bled to death by dividing the blood-vessels under the tongue, the object of which is said to be to make the flesh whiter by extracting the blood. The method may appear cruel, but it does not appear that bleeding to death is attended with much pain to any animal.

Sect. V.—pheasant (*Phasianus colchicus*, Linn.).

2004. This beautiful bird, adorned with rich and splendid plumage, is of the same genus with the common fowl, and crows not unlike the cock. It is said to have been discovered by the Argonauts on the banks of the Phasis, near Mount Ararat, in their expedition to Cholchis, whence the name; and so highly was it thought of by the Greeks, that when Crœsus, king of Lydia, seated on his throne in all the pomp of eastern splendour, asked Solon, then his guest, whether he had ever seen such magnificence before, the philosopher replied that he had seen the beautiful plumage of the pheasant, which he thought superior. The common European or English pheasant has been long naturalized in the warmest and most woody counties of England, and is brown, with less brilliancy of colouring than some foreign varieties which have lately been introduced as fancy breeds, such as the gold and silver pheasants, natives of China, the ring-necks, natives of Tartary, the Bohemian, &c. The golden pheasant is the largest and most hardy.

2005. *The common pheasants are much prized in parks for their beautiful plumage, and are carefully protected as game on account of the delicacy and fine flavour of their flesh.* They feed upon all sorts of insects, like the peacock, as also upon small fruits and seeds, and require woods to shelter them. The cock is voracious and cruel.

2006. *They may be domesticated, though not easily;* but the flesh of those brought up in the house is not comparable to that of the wild pheasant. Upon this bird M. Ude observes: "It is not often that pheasants are met with possessing that exquisite taste which is acquired only by long keeping, as the damp of this climate prevents their being kept so long as they are in other countries. The hens, in general, are the most delicate. The cocks show their age by their spurs. They are only fit to be eaten when the blood begins to run from the bill, which is commonly six days or a week after they have been killed. The flesh of the pheasant is white, tender, and has a good flavour, if you keep it long enough; if not, it has no more than a common fowl or hen." It is in season from October to February, is best a year old, and fat. This bird is very common in France, and, before the Revolution, used to be a great nuisance to the farmers, even near to Paris.

Sect. VI.—partridge (*Tetrao Perdrix*).

2007. *Partridges are to be found in all the temperate countries in Europe,* but are unable to sustain rigorous cold or intense heat: they are most abundant in the Ukraine. They were formerly so common in France that the cultivators were obliged to sow three or four times the corn that was necessary to raise a crop, so destructive are they to the grain. They delight in the concealment of corn-fields, feeding, like the pheasant, upon insects and seeds, and are particularly fond of wild mustard. When the winter comes on, they retire to the upland meadows, and hide themselves among the grass. The partridge is a timorous and simple bird, and is easily taken: it has not been domesticated, though it might be reared like the pheasant.

2008. *It is not equal in point of flavour to grouse, but is considered as a table luxury* in England. Partridges should be chosen young; old birds are good for nothing: when young, they are generally distinguished by a dark-coloured bill and yellow legs; as they

get older, the legs turn gray. There is a red-legged partridge, but it is rare in England. The season for the common partridge is from September to February. Partridges, when young, covey together, and thus the sportsman often shoots several at once.

SECT. VII.—BUSTARD (*Otis Tarda*, Linn.).

2009. *This is the largest land bird of Europe*, the male weighing from twenty-five to thirty pounds, and is a native of England. There were formerly flocks of bustards in forty or fifty, in this country, upon the wastes and in the woods, particularly in Norfolk, Cambridgeshire, and Dorset, as well as in various parts of Scotland; but they are now very rarely seen wild here, though still common on the coasts of the Mediterranean. The bustard runs with great rapidity, so as to elude the pursuit of common dogs, but falls a victim to the greyhound, which often overtakes it before it can commence its flight, the preparation for which, in this bird, is slow and laborious, and it flies with great difficulty. The hunting of the bustard was an ancient diversion. The head and neck of the male are ash-coloured; the back barred transversely with black; the belly is white. Their flesh has been ever held most delicious, and they feed principally upon grapes, grain, and worms. The male is distinguished by a circumstance wanting in the female, which is the possession of a large pouch from the throat to the breast, capable of holding several pints of water. They are bred occasionally, feeding like the turkey; and it would appear that they are an object peculiarly deserving of attention with regard to propagation and increase, as it is probable that its flesh will well repay the expense of its food. Bustards are sometimes to be had in Paris, but they are expensive fare, costing generally 4*l*. or 5*l*. each. Captain Cook discovered a prodigious number of them in a bay of Australia, which is, in consequence, named Bustard Bay. Besides this large species, a smaller species sometimes appears in England (*O. tretrax*) not larger than a pheasant.

SECT. VIII.—QUAIL (*Tetrao Coturnix*, Linn.).

2010. *This bird is a native of the East*, and abounds in the Greek islands of the Archipelago, and in Italy. It also inhabits Egypt, and formed one of the supplies which the Israelites obtained while in the wilderness. Quails are birds of passage, and migrate from warmer regions in the spring to colder in autumn. It may be said, indeed, to be a universal inhabitant of the old Continent, but not of the new.

2011. *Quails are found, though rarely, in England*; some entirely quitting it, others shifting their quarters from one country to another, and sheltering themselves, on the approach of winter, among the woods near the sea-coast. They are not domesticated here, and may be reared and preserved in the same manner as the pheasant and partridge; their food is nearly the same as that of the latter bird: when wild, they frequent corn-fields and meadows, and are ensnared by sounding a quail-pipe, an instrument made to imitate the voice of the hen. They are very abundant in France, and are caught in snares, and sent both to Paris and to the London market. The island of Capri, near Naples, produces such vast numbers of them, in consequence of its bishop's income having been formerly paid from the profits arising from them, that the island is sometimes called the Bishopric of Quails. So many as 800,000 have been taken near to Naples in one day; and Buffon states that sometimes clouds of them are seen on the French coast. They are sometimes imported from Turkey and the Greek islands, preserved in fat or clarified butter. With us, they are occasionally seen alive, fattening in cages; and at the poulterers' they sell for three shillings each. Some persons esteem them; but M. Ude says, "Quails, in my opinion, have no flavour; it is only their rarity that makes them fashionable." They are good only when fat. This bird was proverbial among the ancient Greeks as captious and quarrelsome; and quail fighting was one of the sports of the Athenians, as it is among the Chinese in the present day.

SECT. IX.—PEACOCK (*Pavo Cristatus*, Linn.).

2012. *This beautiful and majestic bird is a native of India*, and is found in a wild state in Java and Ceylon, where they perch upon trees like the turkey in America. When the conquering Alexander led his armies into the peaceful plains of India, he is said to have been so struck by the sight of the peacock in the full magnificence of its plumage, that he forbade any one to destroy them under pain of death: but its antiquity we learn from the history of King Solomon, and the choice of the goddess Juno, who regarded it as her favourite bird. The peacock has been introduced on the table by the ancients as well as by the moderns, but rather as a showy and ornamental dish, being preserved in some of its fine plumage.

2013. *The flesh is coarse and ill-coloured*, and is scarcely ever eaten in these times. At three years old the splendid tail is complete; and it lives to the age of twenty years. Its chief value is as an ornament to pleasure-grounds, where it is useful in destroying reptiles.

SECT. X.—SWAN (*Cygnus Mansuetus*, Linn.).

2014. *It is now known that the wild swan* (*Cygnus ferus*) *is a distinct species from the*

tame bird of the same name. The trachea or windpipe in the latter is simple and straight; but in the wild swan, after entering the chest a little way, it is reflected from thence in the form of a trumpet, and, again returning, divides into two branches. This structure enables the bird to make the powerful note which it utters in its flight, and which can be often heard when the bird itself is so high as to be invisible.

2015. *The wild swan is gregarious and migratory.* It visits Britain occasionally, and may be seen resting in flocks of five or six, but does not remain here long. It is rather smaller and more slender in its form than the tame species. The flesh of the wild swan is not only eatable, but is held in much consideration in the North of Europe and in America.

2016. *The tame swan* is chiefly esteemed with us as a favourite ornament in sheets of water in parks; for its flesh is ill-flavoured except when they are young, or cygnets, when it resembles the pigeon in taste. It is remarkable, however, that the Romans considered the swan as a great delicacy, while the flesh of the goose was reckoned by them impure and indigestible.

2017. *In former times the swan was served up at every great feast in England* as a dish of state, when the elegance of the table was measured by the size and quantity of the cheer: cygnets were fattened at Norwich for Christmas fare.

Sect. XI.—Goose (*Anser Domesticus*).

2018. *The goose is pretty generally spread over the globe,* being met with in Arabia, Persia, North America, Lapland, and Iceland. The colour of the wild goose is uniformly gray, and the taste of the flesh strong and fishy. It frequents the fens of Lincolnshire and other places, and breeds there in the summer; they appear there in large flocks, and are migratory. They are easily tamed and domesticated, which produces a change in the colour of their plumage, no two being then exactly alike, though the predominating colour is white.

2019. *The varieties of the goose are very great* in different parts of the world; but we have only one species in England in common use, which appears to be an English breed. The Chinese and the Canadian goose are kept sometimes, but only for ornament, in pleasure grounds.

2020. *The best geese in England* are probably to be found on the borders of Suffolk and Norfolk, and in Berkshire; but the largest flocks are kept in the fens of Lincolnshire and Cambridge, many persons there having 1000 breeders. Geese, being aquatic birds, thrive best when they have access to water, as in fens, marshes, and grassy-margined pools. Vast droves are sent from the fens every year, to be fattened by the London poulterers. Besides these, prodigious numbers are kept all over the kingdom, on commons, in farmyards, and by cottagers. Part of these provide themselves with food in the summer and harvest, when they are turned in among the stubble to fatten upon the scattered grain.

2021. *The natural food of wild geese* is chiefly of an animal nature; but the tame goose feeds upon vegetables, as grass, corn of all kinds, with garden vegetables, raw or boiled. They are easily fattened by allowing them plenty of food and liberty. In some places it is the custom to cram them; and cruel methods are employed in France and Germany to produce large and fat livers, from which are prepared the celebrated *pâtés.* We are informed by Mrs. Trollope, that "There is one much-prized delicacy that never fails at Vienna; the *pâté de foie gras* seems to be considered as indispensable. Out of twenty-one dinner tables, I have missed it but at two; and as, moreover, no ball-supper is considered as perfect without it, the number of invalided geese must be greater than it is agreeable to think of." Some prefer a goose entirely fattened on the stubble, granting it to have been previously in good case; an over-fattened goose is too oily for delicate flavour. When required to be fattened, feeding-houses are best, where they may be given oats, pease, and bean meal, pollard mixed with the skimmed milk with plenty of water, and clean beds of straw.

2022. *The goose, though apparently a stupid bird, is roused by the least noise in the night,* and the immediate cackling converse which they begin to hold in the approach of apprehended danger is considered as a valuable safeguard, a memorable example of which was their saving the Capitol of Rome from an attack by the Gauls.

2023. *Though greatly relished by some persons as food,* it is not a universal favourite. The flesh abounds in flavour, and is considered to be highly stimulant. When young it is tender, but, in general, it is only adapted for good stomachs and powerful digestion, and should be sparingly used by the sedentary and weak, and by persons subject to cutaneous diseases. Its strong flavour is by some thought to require modification by stuffing with sage and onions, though others relish it only when this is not demanded. From the various parts, however, many savoury dishes are prepared, for which we refer to the receipts on that subject. The fat is reckoned peculiarly subtle, penetrating, and resolvent, and is usually preserved for domestic applications.

2024. *The average weight* of the large kind of geese is from nine to fifteen pounds, and instances have been known of their weighing thirty pounds when fully fattened; but the smaller breeds are preferable for the table.

2025. *It is generally considered that geese are in the greatest perfection about Michaelmas*, because then they have had the feeding upon the stubble after harvest; but, says Dr. Kitchener, though "a Michaelmas goose is as famous in the mouths of the million as the minced pie at Christmas, yet for those who eat with delicacy it is at that time too full-grown. The true period when the goose is in the highest perfection is when it has just acquired its full growth, and not begun to harden. If the March goose is insipid, the Michaelmas goose is rank; the fine time is between both—from the second week in June to the first in September."—*Cook's Oracle.*

In England the goose is sacred to St. Michael: in France to St. Martin. The Michaelmas goose is said to owe its origin to Queen Elizabeth's dining on one at the table of an English baronet on that day when she received tidings of the dispersion of the Spanish Armada, in commemoration of which she ordered the goose to make its appearance every Michaelmas.

2026. *Geese are called green* till they are four months old. They are roasted with pepper and salt only, instead of being stuffed with sage and onion like full-grown geese. These are, of course, early in the season, when the price is high.

2027. *Geese are in some places dried and smoked:* the smoked geese of the Orkneys used to be famous; at present they are little used.

2028. *It is not altogether on account of their use as food that this bird is valuable;* their feathers, their down, and their quills have long been considered as articles of more importance, and from which their owners reap more advantages. In this respect, the poor creatures have not been spared: urged by avarice, their inhuman masters, in some places, appear to have ascertained the exact quantity of plumage of which they can bear to be robbed, without being deprived of life. Mr. Pennant, in describing the methods used in Lincolnshire, in breeding, rearing, and plucking geese, says they are plucked five times in the year; first, at Lady Day for the feathers and quills; and this business is renewed, for the feathers only, four times more between that and Michaelmas: he adds, that he saw the operation performed upon goslings of six weeks old, from which the feathers of the tails were plucked; and that numbers of them die when the season afterward proves cold. We will not vouch that this is the present practice.

2029. *The Canada goose* is so numerous in Hudson's Bay as to form a principal part of the food of the English there, who, in favourable years, salt and barrel vast quantities of them. They are chiefly taken by the Indians, who have the talent to imitate their cackling, and thus decoy them within reach of their shot. Captain Ross describes them as of exquisite flavour. Their feathers are sent to England.

2030. *The so-called Solan goose* is frequently eaten in the Hebrides of Scotland; but their flavour partakes of that of their fishy food; this, however, they loose when they are salted and smoked for winter's store; in that state they are much relished by the inhabitants. We may just observe that this bird is not arranged by naturalists in the genus *anas*; it is, in fact, not a goose, but a pelican (*Pelicanus Bassanus*).

Sect. XII.—Duck (*Anas Buschus*, Linn.).

2031. *The duck is a native of Britain*, and frequents the edges and banks of lakes in most parts of Europe. The tribe called *anas* of Linnæus is very extensive, and comprehends several families of aquatic birds, as the swan, goose, duck, teal, and widgeon, distinguished by being web-footed, and having a flat bill with the edges divided into teeth.

2032. *The wild duck* makes its summer abode in the desolate, fenny parts of our island; and when the severity of winter deprives them of food, necessity forces them to retire towards the sea in numerous flights, where they find water unfrozen, and where they remain till the return of summer. The flesh of the wild duck is not so general a favourite as that of the tame bird; when they are taken on the seacoast they have usually more or less of a fishy flavour; but those from the fens of Lincolnshire are free from that rankness, and have a fine, rich, gamy taste: these are much esteemed as being very savoury, and are sold by the poulterers in London, at a reasonable price, in the season. There are many varieties of the wild duck in foreign countries.

2033. *Great numbers of wild ducks are taken by a singular contrivance called decoys*, which are places into which they are allured by ducks bred up for the purpose. These decoys consist of a pond surrounded by wood in a marshy country. From the pond several canals lead in different directions, and terminate in a narrow ditch that is closed at last with a funnel net. Over these canals are arched hoops, and upon them a continued netting. The wild ducks settle on the pond to feed, and the decoy man is concealed behind a screen of reeds. The decoy ducks are trained so as to lead the way in search of food into the canals, and the wild birds follow; the decoy man then appears, and drives them farther up, where ultimately they are taken in the nets in great numbers. There are many of these decoys in the fens of Lincolnshire, from which the London market is supplied.

Among other methods of catching wild ducks, the ingenious mode so characteristic of the Chinese may be mentioned. Large hollow gourds are purposely thrown into the water in great numbers, and allowed to float

about. The birds being at length accustomed to approach them with impunity, their captors disguise themselves by placing similar gourds over their heads, with holes to see and breathe through, very much in the manner of a helmet. Then, wading quietly along the shallow waters, they have only to approach the birds gently, and pull them under water by their legs in succession. The same method is practised by the American Indians.

2034. *Tame ducks* are well known to be greedy, and not nice feeders. They require a mixture of animal with vegetable food, being accustomed, in the natural state, to live on worms, which they are always seeking for in the water. They will eat flesh and garbage of any kind; but water insects, vegetables, corn, and pulse, are their proper nutriment. If fed much upon grain they fatten rapidly, and the flesh becomes delicate, but is apt to be insipid; and if fed too much upon animal food, their taste is strong, and more like wild fowl. They require water, and that which is stagnant is best, as affording more nourishment from weeds and insects. They are sometimes fattened in coops; but they become of a more delicate flavour, fatten equally well, and are more wholesome by having access to a pond with plenty of food. Their flesh is savoury and stimulant, and is considered to be less gross than that of the goose, as well as more easily digested.

2035. *The character of the duck* is particularly inoffensive and harmless, and is even distinguished by its social disposition. It is also valuable for its great fecundity, and the cheapness and ease with which it may be provided for.

2036. *Though ducks are well known on the table in the time of green pease*, yet Ude says that "November is their proper season, when they are plump and fat." By artificial means they may be had in their prime about Christmas, and this object is effected in some parts of England by preventing the laying of the eggs until the end of autumn; they are then hatched, and the birds fattened.

2037. *Ducks' eggs* are, in general, easily distinguished from those of the fowl, being more of a bluish colour, though some are nearly as white. When boiled, the white is never so curdy as that of the hen, but a little translucent, even when set, and the yolk is darker in colour. They have a peculiar flavour, which some dislike and others prefer; but they have a more binding quality, and are therefore preferable to hens' eggs for making puddings and pastry: a property which, in France, occasions them to be much sought after for omelets and cakes.

Sect. XIII.—widgeon.

2038. The widgeon is a smaller bird of the duck genus, but not so good as the wild duck. It is often fishy and rank, and the flesh is dark and dry; some, however, consider it as well flavoured, and a good wild fowl. It is in season from October to December.

Sect. XIV.—teal.

2039. This is the smallest of the duck tribe, and much superior to the widgeon. It is, indeed, favourite game.

Sect. XV.—pigeon (*Columbus*, Linn.).

2040. This genus is found in all the warm and temperate regions of the globe, particularly in the former; and so numerous are the species, that above a hundred have been enumerated; most of these are wild, but several have been domesticated.

2041. *We have in England two species of wild pigeons* distinct from the domesticated species. The *wood pigeons* or *ring-doves* (*Columba Palumbus*, Linn.) build their nests on lofty trees, as the beech, elm, and oak, and are thought to migrate from the northern to the southern parts of the island, according to the season of the year: they appear sometimes in considerable flocks, and afford much amusement to the sportsman, while their flesh is highly prized. They are of a bluish ash-colour, the neck green and copper-colour, with patches of white. In Carolina they appear in such numbers that they darken the air in their flight, and are found to be so fat that oil is extracted from them. The *turtle dove* is another wild species, of an elegant form but diminutive size, that visits us in spring and disappears in September. It builds its nest in deep recesses of the woods, but is not plentiful.

2042. *The stock dove is the original of our domesticated pigeons*, and is sometimes in a wild state. In its natural state it is of a deep-blue and ash-colour, the breast of a changeable green and purple; on its wings are two bars of black; on the quill feathers another, and also black on the end of the tail; the back white. It inhabits the hollows of rocks and other similar situations. In its domestic or cultivated state the pigeon runs into a number of beautiful varieties, the culture of which forms a particular kind of business: thus we have the carriers, croppers, pouters, horsemen, runts, and a number of others, known to the fancy breeders.

2043. *The blue dove house pigeon* is rather larger than the wild, and is the only variety that is bred up for the table in this country in great numbers in farmyards. Tame pigeons live entirely on grain, pease, small beans, and seeds; they are very ravenous, particularly when young, consuming a great deal of food, and, consequently, are costly. When young, and still fed by their parents, they are called *squabs*, and are then prefer-

able for the table; under six months old they are termed *squeakers;* and at six months they begin to breed: the old bird is tough, dry, and insipid. The flesh of pigeons is highly savoury, delicate, and stimulating, and is dressed in a great variety of ways, of which the most common with us is making it into pies. The dark-coloured pigeons are considered to have the highest flavour, but the light-coloured to have the most delicate flesh. They breed fast, and, when well supplied with food, will furnish squabs every month in the year. But they are kept less than formerly, being found extremely destructive to the crops, particularly of pease, the loss of which to the farmer is very considerable.

Sect. XVI.—Lark (*Alauda Arvensis*, Linn.).

2044. The lively notes of this little songster cannot save it from the gormandizing powers of man.

2045. *Though so small, larks have, it seems, always been sought after as an exquisite morsel.* They were not only caught, but reared and fattened for the Roman epicures; and our markets are abundantly supplied with them, being captured in the winter season, from September till February, in immense numbers, particularly about Dunstable, Cambridge, &c. It is remarkable that the propensity which they have to fly towards a light is converted into a method of decoying them. Mirrors reflecting the sun's rays are placed so as to revolve and attract them into nets placed to ensnare them. They are generally roasted, many together, on a lark spit, and are among our greatest delicacies. It is reckoned that 4000 dozen are annually sold in London.

Sect. XVII.—Crane.

2046. *The crane belongs to a class of birds called Grallæ*, or waders, distinguished by the length of their naked legs, walking, as it were, upon stilts, the signification of the Latin word grallæ. The birds in this class are the crane, heron, stork, bittern, plover, snipe, coot, rail, and a few others. All of them seek their food, consisting of small fish, worms, and insects, in shallow water and marshes, but they likewise eat grain. The crane is migratory, and now a rare visitant to us, though it was once a constant inhabitant of Britain, and was formerly so great a favourite that there was a penalty for destroying its eggs. Its flesh is coarse, except when young.

2047. *The heron and stork* are never eaten with us at present, although, like the crane, they were once common at feasts: in France the heron was formerly considered as royal game, and the young highly prized.

2048. *The bittern* is a good deal like the heron, but shorter and rounder in its body. It is considered as an excellent bird, though less esteemed than it used to be.

Sect. XVIII.—Snipe.

2049. This is a migratory bird, and one of those which are the most generally distributed over Europe. It prefers a cold climate to breed in, but is met with even in India. It is one of the waders, and frequents morasses and places where there is much water, and where worms are abundant; it feeds upon these, but likewise occasionally upon corn and rice. Sir H. Davy informs us that they are extremely fat and delicious during their migration from the north to the south in the marshes of Italy and Carniola, and then resemble the ortolan of Italy. With us they are fattest in frosty weather, when they haunt only warm springs, where they find plenty of worms or larvæ. A few breed in the marshes of England, but more in the Hebrides and Orkneys.

Sect. XIX.—Plover.

2050. The plover is a wild water fowl, but often seeks its food on the arable land in the vicinity of the sea. It has a peculiar cry, which is easily imitated by the sportsman, and is thus lured to its destruction. They roost on the ground, and are sometimes taken with nets by hundreds. There are two species of this bird, the gray and the green; the former being somewhat less than the woodcock, though larger than the green. The green plover is generally preferred for its flavour, but both are inferior to the woodcock. Prodigious flights of these birds, consisting of many thousands, are to be seen in the Hebrides and other parts of Scotland; and in the winter such numbers are sent to London that the market is sometimes quite glutted with them, and they are sold very cheap. They are kept till they have a game flavour, previous to dressing; but though a great favourite with many, they have a peculiar taste not universally relished. Plovers' eggs are considered to be a great delicacy, and are easily to be had from the poulterers; they are generally brought to table boiled hard, but are occasionally eaten raw.

Sect. XX.—Lapwing (*Tringa Vanellus*, Linn.).

2051. This is commonly known in England by the name of the *bastard plover*. It is frequent in our fenny counties, and in wet places in most parts of England. In winter they are seen in large flocks. Their flesh is very good, their food being insects and worms. The eggs are of an olive cast, spotted with black, and are much esteemed for

their delicacy. Lapwings are taken with nets during October and November, and are sold by London poulterers at three shillings the dozen.

SECT. XXI.—RED GROUSE (*Tetrao Scoticus*, Linn.).

2052. *The beautiful plumage and exquisite flavour of this bird* render it an object of considerable interest. It appears to be a native of Scotland and the north of England, in the mountainous districts of which it is found by sportsmen in great plenty, feeding on various berries that grow among the heather, and also on the tops of this plant; hence it is often called *moor game*, or *moor fowl*. It does not undergo any change of colour in winter, but acquires a greater mass of clothing, and its legs become covered with a sort of hair-like feathers. The breeding season is early in the spring, and the brood continue in company for some months, sometimes joining others which range the high moorlands, where they are shy, and difficult to be approached. Their colour is a rich chestnut, barred with black.

SECT. XXII.—BLACK GROUSE (*Tetrao Tetrix*, Linn.).

2053. This bird, called also the *black cock*, or *moor fowl*, is larger than the red grouse, the male weighing sometimes four pounds, and the female two pounds. It is also less common, and therefore more highly prized. It is met with nowhere in Britain but in the Highlands of Scotland and the mountainous heaths of the north of England. Its plumage is a rich mixture of black and blue relieved by markings of white, and its legs are covered with very minute feathers. The form of its tail is remarkable, branching into two crooked expansions. Its food is similar to that of the last described bird. Vast numbers of these birds are found in Norway of large size, being nearly equal to turkeys; and of late many have been imported into London and sold in the shops; but these are not equal in flavour to the Scotch smaller kind.

SECT. XXIII.—WOODLAND GROUSE (*Tetrao Urogallus*, Linn.).

2054. This is likewise called the "cock of the wood," and is the largest among the birds which we denominate game, it being little less than the turkey. It was originally common in the mountains of Britain, but is now nearly extinct with us, occurring only in the Highlands of Scotland, though still abounding in the north of Europe, Germany, and the Alps, where it lives in pine forests, on the cones of which it is supposed to subsist, and which, at some seasons, gives its flesh a terebinthinated taste. It is in general delicious eating, and is sometimes sent to England preserved in ice. From the great delicacy of its flesh, it is to be lamented that sufficient means have not been taken to domesticate it, which, it is supposed by some sportsmen, would be very practicable. Its plumage is extremely beautiful.

SECT. XXIV.—WHITE GROUSE.

2055. The *white grouse*, or *ptarmigan*, is found in the British isles, though not plentifully; the London market is supplied from Scotland and Norway, those from the latter country being preferred. When young it is excellent, and little different from common grouse. At Hudson's Bay they are in such flocks, that sixty or seventy are often taken in a net at once; and, as they are as tame as chickens, they are driven into the nets without difficulty. A ptarmigan will weigh a pound and a half.

SECT. XXV.—WOODCOCK (*Scolopax Rusticola*, Linn.).

2056. This bird is somewhat less than the partridge, which it much resembles, and is a bird of passage. It breeds in high northern latitudes, as in the marshy and extensive pine forests of Norway, Sweden, Russia, and Siberia, feeding upon worms and insects, which it searches for with its long bill. When winter sets in, woodcocks emigrate and seek a milder climate, the time of their leaving Sweden agreeing with that of their arrival in Britain, where they frequent our woods, particularly in the west and north. In emigrating, they travel slowly, flying low from wood to wood, choosing the night, and concealing themselves during the day. They are with us during the winter, and leave England about the latter end of February, a few only remaining in this country, where they breed. There are woods in England, particularly one in Sussex, near the borders of Hampshire, in which one or two couple of these birds, it is said, may always be found in summer. They have been observed as far south as Asia Minor, Barbary, and Egypt, and they are common in Japan; these probably migrate from the north of Asia. They are taken in great numbers in nets, springes, and with bird-lime, and are served up at the best tables as delicacies, being much esteemed by gourmands as a highly-flavoured viand, resembling the barn-yard fowl in point of delicacy; but they are good only when fat. It is best to keep them before dressing till they are very tender, without suffering them to proceed too far in the progress of decay: they are remarkable for the tenderness of their skin. We are informed, in a contemporary publication, of some curious deceptions practised by the inferior poulterers of London upon genuine cockneys who are ambitious of having game at their tables. "The gray plover is sometimes trussed like a woodcock, its bill cut off, and the bill of a real woodcock inserted instead: the bills of these latter birds being purchased from the cooks of wealthy families." The detec-

tion of this fraud, which, it is hoped, is unusual, is obviously to give the bill a "good tug;" and this suggests the necessity of those who wish to purchase wild fowl being themselves acquainted with the characters of the birds, and not trusting implicitly to the sellers.

The woodcock is not considered game by law, since, being a migratory bird, having no settled habitation, and not being reared or preserved, it cannot be considered as the property of any individual.

SECT. XXVI.—PUFFIN, KITTIWAKE, AND AUK.

2057. These birds live almost entirely in the sea, building their nests in the sea cliffs, and feeding altogether on fish. Though relished by some persons when young, yet their strong and peculiar flavour, derived from their food, prevents their being generally dressed, except in cases of necessity. Pickling and spicing takes off much of the fishy taste. *The sea-gull* is never eaten, the flesh being coarse and strong.

SECT. XXVII.—SWALLOW.

2058. *The swallow is never among the trifles seen at our tables*; but the *edible birds' nests*, which occupy the first rank among the dainties prized by Chinese gourmands, are the production of a species of swallow (*Hirundo esculenta*). These nests are formed of a transparent gelatinous substance that dissolves in water; they are employed for sauces, or in soups, or chicken broth for valetudinarians, and are reckoned an excellent restorative. This rare material is sometimes seen even at the tables of the wealthy and luxurious in Britain. The nests are about three or four inches in circumference, and one in depth, and are met with in clefts of the rocks on the shores of Cochin China, Java, Malacca, and various parts of the Indian Archipelago. They are found in great quantities in the islands on the Tavoy coast and in the Mergui Islands in Siam. Malay, Chinese, and Siamese boats come every year for six weeks in January to collect them. Taking them is a work of considerable danger, as it is necessary to climb precipices by the help of ropes and flying ladders made of ratans, and many are found in intricate caves. The Chinese, among whom the extremes of luxury and misery are frequent, pay five or six dollars a pound for them; when first brought in their raw state, they are covered with dirt and feathers, from which they are cleared before they are offered for sale. It is said that Batavia alone exports annually 4,000,000 of these nests to supply the tables of the Chinese mandarins. The substance which the bird collects to compose these edible nests does not appear to be yet clearly ascertained. Dr. Mayen, in his voyage round the world, states that the swallow eats a species of marine fucus (Sparococcus cartalagineus, var. cetaceus), which grows in great abundance in the Indian seas; and, after permitting it to soften for some time in its gullet, it disgorges the substance, now converted into a kind of jelly, and uses it as a cement for its nest; and it has been said that the Japanese, who have long ago discovered this fact, prepare the substance in an artist-like manner. The vegetable origin of the substance in question has, however, lately been opposed in the "Journal de Pharmacie," August, 1836, by M. Virey, who maintains, with Rumphius, that the swallow collects from the surface of the sea the gelatinous material of some species of marine mollusca, from which it would appear that the edible nests consist of animal substances.

SECT. XXVIII.—WHEAT-EAR.

2059. *This is a delicate little bird of passage about the size of a lark*, but difficult to be procured at the poulterers' in London, unless ordered. They visit us, and are in season from July to October; they are obtained chiefly on the South Downs in the neighbourhood of Brighton, Eastbourn, and other parts of Sussex, and may be had at Tunbridge Wells. They are caught in nets and snares like larks, and are occasionally captured in immense numbers. They are usually sold at a high price; the larger are sent to London and potted, when they are by many as much esteemed as the ortolan of the Continent; but, from their fatness, they will not keep long without spoiling, and can be had in perfection only in the districts where they are caught.

SECT. XXIX.—LANDRAIL, OR CORNCRAKE.

2060. The landrail is known by its peculiar voice, like the sound of a watchman's rattle; and it trusts more to its swift foot among the corn or long grass than to its wings, which it rarely uses. It is seldom caught; but when in good condition, it is reckoned a first-rate delicacy. When fully grown, they weigh about half a pound.

SECT. XXX.—ORTOLAN.

2061. This small singing bird is considered one of the greatest luxuries of the table. It is migratory, but is never found wild in Britain, though common in France, Italy, and the warmer parts of Europe; consequently, in this country it is rarely procurable, and in its cost may rank with the turtle among the list of expensive delicacies. They are sometimes bred in cages, and are kept in a dark room, where they can have no employment but eating; in consequence, they get inordinately fat, and would die of this disease if the knife did not interpose when they have arrived at the desired point of obesity. When well fed, they weigh about three ounces each, and are roasted with the intestines in them. They are sometimes imported, potted, from the south of France and Italy.

SECT. XXXI.—EGGS.

2062. *Eggs form an important article of food*, and they have been chemically examined by several analysts, particularly Dr. Prout and Dr. Bostock. The eggs of birds are composed of several distinct substances; as the shell, the white, and the yolk.

2063. *The shell*, or external coating, is formed chiefly of carbonate of lime. It consists in 100 parts, of carbonate of lime, 72; phosphate of lime and magnesia, 2; gelatin, 3; the remainder, perhaps, water. It is supposed that birds pick up carbonate of lime with their food to supply materials for the shells of their eggs; for it is remarked, if care be taken that their food shall contain none of this earth, they will lay eggs without shells.

Egg-shells, on account of their calcareous nature, are often employed for the same purposes as chalk or lime, in correcting acidities, &c. They are observed to be filled with numerous minute pores, which should be closed by rubbing some substance over them when the eggs are to be preserved. The *thin membrane* immediately beneath the shell is, in some eggs, much stronger than in others, and is considered to be coagulated albumen.

2064. *The white of egg* is generally mentioned as being composed only of albumen, and, indeed, is referred to often as an example of pure albumen; but Dr. Bostock has given the most complete analysis of it, from which it is shown to consist of 80 parts water, 15 albumen, and 4·5 mucus. It is a glairy, insipid fluid that mixes readily with water when raw, and is often used as a varnish, like gum; it is also employed to clarify liquors. It much resembles serum of blood in its composition and properties. The white of the egg has been found, by accurate observation, to consist of two parts: the external part, or that immediately under the membrane that lines the shell, is always most abundant in newly-laid eggs. When the egg is raw, this part is almost as liquid as water, and evaporates by keeping. In eggs that have been long kept, it is scarcely observed; the inner white is by much the most considerable, and this sets, or acquires a firmer consistence, in boiling. Newly-laid eggs are heavier than water, and sink in it; but, in consequence of the evaporation of the internal white through the pores of the shell, they become lighter; hence old and bad eggs swim in water. Hens' eggs have the albumen, when coagulated by boiling, of a beautiful, opaque, milk-white substance, if they are quite fresh; but if not, it is a dirty or yellowish white, and not firm.

2065. *The yolk* has a mild and peculiar taste, and appears to consist of a deep yellow-coloured oil of the nature of fat oils, united to a portion of albumen sufficient to render it diffusible in cold water, in the form of an emulsion. It contains also a little sulphur and phosphorus, the former being evident from its blackening a silver spoon, the black stain arising from some of the silver uniting to the sulphur, and forming a sulphuret of silver, which is naturally of a black colour; consequently, this stain cannot be removed without rubbing off this part of the silver that has been altered. The use of the phosphorus is supposed to be in order to supply that principle to the bones of the young chick. The yolk is concrescible by heat, and becomes solid by boiling. It is employed as a medium for uniting resins and oils with water. The yolk is itself surrounded by an extremely thin membrane which separates it from the white.

2066. *The eggs of different birds vary much in size and colour.* Those of the ostrich are largest. One laid in the menagerie in Paris weighed two pounds fourteen ounces, held a pint, and was six inches deep: this is about the usual size of those brought from Africa. Travellers describe ostrich eggs as of an agreeable taste: they keep longer than hens' eggs. Drinking-cups are often made of the shell, which is very strong. The eggs of the turkey are almost as mild as those of the hen; that of the goose is large, but well-tasted. Ducks' eggs have a peculiar taste; the albumen is slightly transparent, or bluish, when set or coagulated by boiling, which requires less time than hens' eggs. Guinea-fowl eggs are smaller and more delicate than those of the hen.

2067. *The eggs of wild fowl* are generally coloured, often spotted, and the taste generally partakes somewhat of the flavour of the bird they belong to. Those of land birds that are eaten, as the plover, lapwing, ruff, &c., are in general much esteemed, but those of sea fowl have more or less of a strong fishy taste. The eggs of the turtle are very numerous; they consist of yolk only without shell, and are delicious.

2068. *As food, eggs are extremely nutritious.* The qualities of those belonging to different birds vary somewhat. Those of the common hen are most esteemed as delicate food, particularly when newly laid; the quality of the eggs depends much upon the food given to the hen. Eggs, in general, are considered as most easily digestible when little subjected to the art of cookery. The lightest way of dressing them is by poaching, which is effected by putting them for a minute into brisk boiling water; this coagulates the external white, without doing the inner part too much. Every one knows how much better they are when *newly laid* than for a day or two after they are laid. The usual time allotted for boiling eggs in the shell is three minutes, which should always be measured by a sand-glass. Less time than that in boiling water will not be sufficient to solidify the white; and more will make the yolk hard and less digestible; it is very difficult to guess accurately as to the time. Great care should be employed in putting them into the water, to prevent cracking the shell, which inevitably causes a portion of the white to exude, and lets water into the egg. They are often beaten up raw in nutritive beverages.

Eggs are employed in a very great many articles of cookery, entrées, entremets, and sucrés, and they form an essential ingredient in pastry, creams, flip, &c. It is particularly necessary that they should be quite fresh, as nothing is worse than stale eggs.

2069. *The metropolis is supplied with eggs* from all parts of the kingdom, and they are likewise largely imported from various places on the Continent, as France, Holland, Belgium, Guernsey, and Jersey. It appears from official statements mentioned in M'Culloch's "Commercial Dictionary," that the number imported from France alone

amounts to about sixty millions a year; and supposing them, on an average, to cost four pence per dozen, it follows that we pay our continental neighbours above 83,000*l.* a year for eggs.

2070. *For the method of preserving eggs*, see Chap. III., Book X., "On the Preservation of Food."

CHAPTER VI.

FISH.

SECT. I.—GENERAL OBSERVATIONS ON FISH.

2071. *In the ocean there appears to be an inexhaustible store of food in the finny tribes of animals.* Although in London fish is highly esteemed and considered rather as a luxury, yet in all countries where it is plentiful and cheap it is reckoned somewhat inferior in its nutritive powers to what is called butchers' meat. This is so well known, that the jockeys who ride at Newmarket, and who wish to weigh as little as possible, are never allowed to eat meat if fish can be obtained. The ancient Greeks seem to have looked upon fish in the same light, for we find in the Odyssey, Menelaus complaining that they had been obliged to live upon fish. Nevertheless, as the inhabitants of the seacoast in many parts of the world subsist almost entirely upon this kind of food, and enjoy perfect health, it is evidently, in general, sufficiently substantial. In Siberia, parts of Norway and Iceland, dried fish composes the principal part of the food of the inhabitants; and in Greenland and the Polar Seas the Esquimaux have no other. Being, however, less nutritive than meat, a larger quantity is necessary for sustenance. But though not so strengthening, it has some qualities which render it particularly valuable. Being less stimulating than butchers' meat, it occasions less febrile excitement, and being extremely tender and soluble, it is more easy of digestion; and though not sufficient, in all cases, to restore power to habits debilitated by disease, it is well suited for invalids, for inhabitants of towns, and for sedentary or studious persons.

2072. *Fish, however, like other animals, differ in some degree in their nutritive and other properties*; much, likewise, depends upon the modes in which they are prepared before they are employed as food. Like every other kind of aliment, it is preferable in its fresh state, but vast quantities are also salted, pickled, or dried, by which operations it is considerably altered in its properties.

2073. *Fishes may be separated into three great divisions* relatively to their habits, and the waters where they live. 1. Those which live entirely in the sea, hence called *salt-water fish*, as the cod and herring. 2. Those which live always in *fresh water*, as char, trout, &c. 3. Those which *migrate from the sea to the fresh water*, living alternately in each, as the salmon and sturgeon. Their natural history is a subject of great interest, but we can only touch upon such parts of it as bear upon their fitness for food; at the same time remarking that, as the article fish forms no inconsiderable figure on the table, the study of its good and bad qualities becomes a subject very deserving attention.

2074. *Fishes present considerable variety in the structure and firmness of their muscles.* The muscles of some fish resemble flesh, as that of the whale, shark, and sturgeon: of others it is white, and disposed in flakes, as in the cod and the haddock; and in others, again, it is fibrous, as in flat fish and eels. In general, the muscular part is less firm than that of land animals; in some it is comparatively dry; in some, soft and gelatinous; and in others fat and oily. The fat or oil is sometimes disposed between the layers of the flesh, as in salmon, or it is dispersed through the flesh, as in eels, herrings, sprats, &c. In the cod a curdy matter, resembling coagulated albumen, appears between the flakes of the flesh when fish perfectly fresh is cooked; this disappearing entirely when the fish is stale, furnishes a good test of its condition: the fat or oil of cod resides only in the liver. Flat fish and eels have none of this curdy matter, the flesh not being in flakes. All the livers of fish abound in oil. Fish having much fat or oil mingled with their muscles are less digestible than those which are leaner, but they are more nutritive, as, for instance, salmon, eels, and herring. Some of the cartilaginous fish, as skate, are also extremely nutritive.

2075. *Some fish are said to be poisonous*, but these reside chiefly in the tropical seas, and never visit our coasts.

2076. *The flavour of fish*, like that of other animals, is influenced in a certain degree by the nature of their food, and on this account the same species of fish will vary somewhat in its flavour on different coasts, and in different lakes and rivers. Some fish improve in firmness and flavour as they attain a certain age, as cod and haddock; but generally when they become old they get coarse.

2077. *The season of the year has the most decided influence upon the quality of fish*, as connected with the time of their spawning. Fish, in general, are in the best condition before they spawn, and many while they are full of roe, as the smelt, pouting, mackerel,

and sole; but it is universally the case, that immediately when the spawning is over they are "out of season" and unfit for food: sometimes, indeed, at this time fish are unwholesome. This circumstance is of so much importance, that it has been considered a fit subject for the interference of the legislature, which regulates the times during which only certain fish may be caught. When fish are in season the muscles are firm, and they boil white and curdy; but when they appear transparent and bluish, though sufficiently boiled, it is a sign that the fish is not in season, or is not fresh.

Previous to the approach of the spawning season, there is a natural preparation necessary to enable the fish to undergo the fatigues and fastings by which it is accompanied. The muscles acquire size and strength, especially those connected with the tail, the principal organ of progressive motion, so that the body behind appears plump and round. A great deal of fat is deposited between the muscles, but especially on the belly, the flesh of which is, at this time, of considerable thickness. As the spawn advances to maturity, the fat is withdrawn for its nourishment, the belly becomes little else than skin, and while the epicure, upon seeing the large roe, imagines that his fish is in the best condition, it has nearly reached the maximum of its worthlessness. When the business of spawning is over, the leanness of the fish then becomes apparent, and the extraordinary muscular exhaustion which it has undergone is marked by the thinness of its head and the lankness of its tail.

It appears, however, the same species of fish is occasionally subject to variations in the periods of spawning, which explains the reason why sometimes a fish is found quite good as food, while the rest of the species is poor and inedible. This is the case with cod, and also flat fish. The summer and autumn are the seasons most favourable for the procuring of fish in general, but on account of the various seasons for spawning, no month is without a supply of some particular species.

2078. *Fish surpass in fecundity all other animals used as food.* In the roe of the sturgeon above a million and a half of ova have been counted; in the mackerel, 129,000; in the perch, 69,000; in the carp, 167,000; and in the pike, 166,000.

2079. *Every part of fish may be eaten with safety,* with the exception of those that are poisonous. The hard roe, or that of the female, is particularly nutritious, often large, and forms an excellent food. Caviare is the prepared roe of the sturgeon.

2080. *Naturalists have divided fishes into two great tribes, the osseous and the cartilaginous,* according to the bones. In the first, the bones are more or less hard and firm, and contain a great deal of phosphate of lime, as in the cod and ling; in the latter the bones are soft, and consist only of cartilage, as in the skate. This distinction, however, is not precise, for osseous fishes have a great deal of cartilage, and some of the cartilaginous fishes possess a small portion of calcareous matter in their bones. Nor is the composition of the bones uniform, some having more phosphate of lime than others. Some fish are very gelatinous, as eels, and make excellent soup.

2081. *The skin of most fishes is covered with scales;* but some are almost without, these being very minute, as the eel. The thickness of the skin varies according to the strength of the scales; it is, accordingly, very thick in skate, eels, &c., and thin in those species that possess larger scales, as the carp and bream; hence, in preparing these fish for the table, the former are deprived of their skin, and the latter only of their scales. The surface of the skin of fishes is more or less covered with a slimy, gelatinous, or mucous substance of a peculiar nature, secreted by an apparatus for the purpose, and shed upon the skin by a number of minute ducts or openings: this is a defensive secretion against the friction and washing of the water; but the integument that affords the chief defence to the skin are the scales. Those fish that want scales, or have them very small, have more of the slimy matter, as in eels. Dr. Paris states that the pulpy, gelatinous skin of the turbot, and the glutinous parts about the head of the cod, though highly prized by gastronomes, are very apt to disagree with invalids.

2082. *Little attention is paid to the mode of killing fish,* as the object is to keep them alive as long as possible; but many of them die as soon as they are taken out of the water. The Dutch take great care to bring them alive to market, and those that die are sold at an inferior price; but though this ensures their being fresh, yet, when they are kept long alive, the fish become exhausted, and are worse in quality than if they had been killed when caught, and kept only the proper time: when preserved in the wells of ships, they are frequently rendered poor. Fish, in general, are extremely voracious, the greater number being carnivorous, feeding upon each other, the greater on the smaller; thus the cod pursues the whiting; but some fish live upon marine plants.

2083. *White fish,* whose muscles are the firmest and least oily and viscid, possess the most valuable qualities as food, and are, in particular, the best calculated for invalids. These, comprehending the cod, ling, tusk, coalfish, haddock, and whitings; also the flat fish, as turbot, skate, soles, and flounders, swarm about the British shores, and particularly in the whole northern sea, from the Dogger Bank, in lat. 54°, to the northern extremity of Iceland, in lat. 67°; from the coast of Norway eastward to an unknown distance on the west, may be considered as one great fishery, in which Scotland, as lying in the centre, has a manifest advantage over all other nations. The number of friths

and inlets of the sea, on the west coast of Scotland, render that country peculiarly favourable for the prosecution of fisheries.

The muscles of the red-coloured fish, as salmon, trout, &c., are of a peculiar tint, which has acquired the name of salmon colour, and the fish are generally esteemed in proportion to the height of this colour. They are always more or less of a fat or oily nature.

2084. *Flat fish* are called by naturalists *Pleuronectidæ*. They have no swimming bladder, and therefore keep close at the bottom. Both eyes are on one side, and that side is uppermost: when disturbed, they sometimes make a rapid shoot, changing their position from the horizontal to the vertical, but they soon settle down again into their former position.

Mr. Yarrell observes that those fishes which swim at the bottom of the sea are so constructed as to consume but a small quantity of oxygen, and have their blood only two or three degrees warmer than the temperature of the water at the surface; but they have a high degree of muscular irritability; they retain life long after they are taken out of the water, and their flesh remains good for several days. Various flat fish, and the eel, are seen gaping and writhing on the stalls of the fishmongers for hours in succession. On the contrary, those fish which usually swim near the surface of the water have a high degree of respiration, and their blood has a warmer temperature, which, in the case of the Bonito, amounts to 90° when the water is 80°. These have little irritability, and generally die as soon as they are taken out of the water, which is also the case with the mackerel, salmon, trout, and herring. In consequence of this, the latter class of fishes soon decompose or spoil after they are killed; and, to be in perfection, should be prepared for the table the day they are caught; whereas turbot is better for being kept a day or two, since they are tough while any irritability exists.

2085. *The mode of cooking fish considerably affects their properties as food.* Plain boiling, baking, and roasting appear to be the methods that prepare it in the fittest manner. There appears no reason why stewing should be objectionable, except that it is usually accompanied by numerous additions that render it extremely indigestible, for instance, port wine. The various sauces commonly eaten with fish are probably the cause of most of the faults laid to the charge of this useful aliment; these sauces are to be suspected, when purchased, as we cannot at all times be certain of their composition; and it is well known that they are sometimes deleterious. The observation which we have often made applies here in a particular manner, namely, that it is of the first importance we should *know* what we eat and drink. Few species of vegetables appear to be eaten with fish. Potatoes and parsnips are the principal of those which are found by experience to agree well.

2086. *A process called crimping is sometimes adopted for the purpose of improving cod and some other fish.* Sir Anthony Carlisle has investigated the change thus produced, and we are indebted to him for some curious observations upon the subject. Whenever the rigid contraction has not taken place, the process may be practised with success. The sea fish destined for crimping are usually struck on the head when caught, which, it is said, protracts the term of its irritability; and the muscles which retain this property longest are those about the head. Many transverse sections of the muscles being made, and the fish immersed in cold water, the contractions caused by this crimping take place in about five minutes; but if the mass be large, it often requires thirty minutes to complete the process, which is for the purpose of giving firmness to the fish. It has been found that the muscles subjected to this process have both their absolute weight and specific gravity increased; whence it appears that water is absorbed, and condensation is produced. This operation improves the flavour, as well as the digestibility of the fish.

2087. *The blowing of fish* is a fraudulent practice sometimes employed by fishmongers, of a similar nature to the blowing of flesh and poultry. It is performed especially on cod and whitings, by introducing the end of a quill or tobacco pipe at the vent, and blowing through a hole made with a pin under the fin which is next the gill; thus making the fish appear to the eye full and large, though, when dressed, it will be very different. This imposition may be easily detected, by placing the finger and thumb on each side of the vent, and squeezing it pretty hard, for the air will then be perceived to escape, and the fish will shrink into its natural dimensions.

2088. *The migration of various species of fish* in shoals, and almost infinite multitudes, to particular coasts at certain times of the year, is a circumstance of great advantage to mankind, as it gives an opportunity of taking them with ease, and in vast quantities. The causes that induce fish to make these periodical movements are stated to be the instinct they possess for seeking suitable situations to deposite their spawn, and their search after a supply of food. Several kinds of fish, as the cod, haddock, mackerel, and herring, annually leave the deeper and less accessible parts of the ocean, the region of the zoophytic tribes upon which they prey, and approach the shallow shores to deposite their spawn within that zone of marine vegetation which fringes our coasts, extending from near the high-water mark of neap tides to a short distance below the low-water mark of spring tides. Amid the shelter of this region, afforded by the groves of arborescent fuci, the young fry come to life and spend their infancy in a situation where numerous small animals reside, and which constitute their most suitable food; and it is said that since these marine plants have been cut down on many of the coasts for the

manufacture of kelp, the fisheries have suffered in consequence. Even the finny tribes inhabiting lakes, as the gwinead, and other species, periodically leave the deep water, and, in obedience to a similar law, come near to the margin to deposite their spawn.

2089. Many species of fish, as the salmon, smelt, and others, in forsaking the deep water, and approaching a suitable spawning station, leave the sea altogether for a time, ascend the rivers and their tributary streams, and, having deposited their eggs, return again to their usual haunts. With respect to the migration of herrings, see "Herring," Subsection 21.

2090. *Though it is generally supposed that fish which do not migrate from salt water to fresh*, and which are properly fish of the sea, will not live in fresh water, yet, from some interesting and successful experiments which have been made, it appears that several species of fish decidedly marine may be preserved alive a long time in fresh-water ponds, and that they even thrive and get fat in them. Some very curious observations on this subject have been published by Dr. Macculloch in the *Journal of the Royal Institution*, Nos. 32 and 34, and in the *Edinburgh Review*, 1822.

This capability of some salt-water fish to live in fresh water has long been known in Sicily, where a species of mullet, when taken from the sea, are by the fishermen thrown into the Lake Linterni, where they are kept for use, and where they increase in size and improve in flavour: this lake has no communication with the sea.

2091. *An account of the naturalization of sea fishes in a lake* was lately read at a meeting of the Zoological Society by Mr. J. B. Arnold, of Guernsey. The area of the lake is about five acres; its depth varies, and its bottom is muddy, gravelly, and rocky. The water during nine months of the year is drinkable for cattle, but, in consequence of a supply which it receives through a tunnel communicating with the sea, is rather salt in summer, at which season the freshets do not come down so plentifully as at other times. Several salt-water fish were introduced into it, as turbot, sole, plaice, brill, smelt, gray mullet, whiting, pilchard, bass, and gray roach. All these thrive well, and are believed to have increased in numbers. The gray mullet, in particular, has bred as freely as in the sea. A single whiting, that had been caught three successive years, was found to have grown considerably. Pilchards also throve remarkably well. It is even suspected that hybrid fishes have been produced, as several have been caught which were unknown to persons well acquainted with the species annually met with on the coast of Guernsey. Some of these sea fishes, after having been naturalized in this lake, have been transferred to ponds of spring water, where they have not only lived, but done well; and such naturalized fish have been carried to a long distance, being much more tenacious of life than those caught in the sea.

2092. *The preservation of sea fish in salt-water ponds* is so obvious an idea, that it is surprising to find it so little practised in England; nor is it much known on the Continent. In Scotland, however, this has been tried with success in several places. One of the largest and best of these belongs to Macdonnel, of Leggan, in Wigtonshire, which has been in existence upward of thirty years. This pond is stocked with turbot, cod, haddock, whiting, thornback, coalfish, and salmon. It is stated, also, that the same mode is practised in Todness Island, in Essex, where it answers perfectly well. From these and similar facts, it would appear to be extremely possible to preserve fish for the market in enclosures or ponds made in the mouths of rivers, estuaries, or in the sea, so that a uniform and regular supply of fish might be obtained in all weathers.

2093. *Fresh-water fish are frequently preserved and bred in ponds*; but the abundance of salt-water fish in this country renders those of lakes and ponds comparatively of small importance. Char and trout abound in some lakes, as at Keswick and Loch Lomond; but these fisheries are little attended to. Fish-ponds are most plentiful in the counties of Surrey and Berkshire, and are sometimes let to dealers in carp and other pond fish; but the breeding and fattening fish for the market is much less studied here than on the Continent, where the Roman Catholic religion causes this kind of diet to be more in demand at all seasons. In China this practice is carried to a great extent. The fish most usually kept in ponds are carp, tench, perch, gudgeon, eel, and pike.

All the fresh-water fish are taken occasionally, and most of them solely by the rod and line. The art of angling is more generally practised for amusement than profit; but it is a sport of great antiquity, and is followed with the greatest avidity by persons of every rank in life. It has some advantages over other rural sports; it is but little dangerous, and incurs small expense, and is peculiarly fitted for the placid and thoughtful; accordingly, we find that some men of great eminence have been much attached to it, as affording a relaxation from deep study, and the opportunity of contemplating nature. We may refer, on this subject, to the well-known "Salmonia, or Days of Fly Fishing," written by one of the greatest philosophers of modern times, Sir Humphrey Davy. The laws have ever been favourable to this pursuit, protecting the fish, and the authorized fisher, and punishing the depredations of the poacher. Proprietors of grounds through which rivers or streams pass have the exclusive right of fishing in them, and trespass is punished by fine. The proper season for angling is from the spring to the autumn. The different fish frequent different places, and require various kinds of bait or artificial flies, the study of which, with the numerous circumstances connected with it, will be found in works written "on angling."

2094. *A method of increasing the quantity of trout in rivers or lakes to almost any extent* is mentioned by Sir H. Davy in his "Salmonia," and which he states has been practised by M. Jacobi, a German gentleman.

"His plan of raising trout from the egg was a very simple one. He had a box made with a small wire grating at one end in the cover, for admitting water from a fresh source or stream, and at the other end of the box there were a number of holes to permit the exit of the water; the bottom of the box was filled with pebbles and gravel of different sizes, which were kept in water that was always in motion. In November, or the beginning of December, when the trout were in full maturity for spawning, and collected in the rivers for this purpose upon beds of gravel, he caught males and females in a net, and, by the pressure of his hands, received the ova in a basin of water, and suffered the melt to pass into the basin; in a few minutes he introduced them upon the gravel in the box, which was placed under a source of fresh, cool, and pure water. In a few weeks the eggs burst, and the box was filled with an immense number of young trout, which had a small bag attached to the lower part of their body, containing a part of the yolk of the egg, which was still their nourishment. In this state they were easily carried from place to place in confined portions of fresh water for some days, requiring, apparently, no food; but after about a week, the nourishment in their bag being exhausted, they began to seek their food in the water, and rapidly increased in size. It is said that the experiment succeeds also with the melts of mature fish that had been just killed, if they are mixed together in cold water immediately after they are taken out of the body. One great advantage of this method is, that by

this means the young ones are preserved from the attacks of fishes, and other voracious animals and insects, at the time when they are perfectly helpless and most easily destroyed. The same plan would no doubt answer equally well with grayling, or other varieties of the salmo genus. But, in all experiments of this kind, the great principle is to have a constant current of fresh and aërated water running over the eggs. The uniform supply of air to the fœtus in the egg is essential for its life and growth, and such eggs as are not supplied with water saturated with air are unproductive. The experimentor must be guided exactly by the instinct of the parent fishes, who take care to deposite the impregnated eggs that are to produce their offspring only in sources continually abounding in fresh and aërated water. It appears that the leaves of plants that grow in water afford a continual supply of oxygen to the water, and that many fish possess the instinct to deposite their eggs upon these leaves, a circumstance that affords an easy opportunity of making observations upon the growth of young fish, as the leaves with the ova may be kept in a vessel of water. The same observations will apply to fishes of the sea."

2095. *The art of carrying and keeping fish*, as we are informed by Sir H. Davy, is better understood on the Continent than in England. "In Austria every inn has a box containing grayling, trout, carp, or char, into which water from a spring runs, and no one thinks of carrying or sending *dead* fish for a dinner. A fish barrel full of cool water, which is replenished at every fresh source among these mountains, is carried on the shoulders of the fisherman: and the fish, when confined in wells, are fed with bullocks' liver cut into fine pieces, so that they are often in better season in the tank or stew than when they are taken." Sir Humphrey has "seen trout, grayling, and char even, feed voraciously, and take their food almost from the hand. These methods of carrying and preserving fish have been adopted from the monastic establishments. At Admont, in Styria, attached to the magnificent monastery of that name, are abundant ponds and reservoirs for every species of fresh-water fish; and the char, grayling, and trout are preserved in different waters, covered, enclosed, and under lock and key." Some remnants of the same practice may be seen in the colleges of Cambridge.

Since England became a Protestant country, the cultivation of fresh-water fish has been neglected; but the formation of fish-ponds in hilly or mountainous districts would be a matter of little difficulty, and by this means a considerable addition might be made to the food of these places.

2096. *In China, the art of preserving and fattening fish* is carried to a high degree of perfection. An account of the method used in that country, quoted in the *Quart. Journ. of Science*, is deserving of notice. In the district round Canton numerous fish-tanks are dug in the ground. When the pond is finished, and filled with water, the owner goes to market, and buys as many young store-fish as his pond can conveniently hold; this he can easily do, as almost all their fish are brought to market alive. Placed in the pond, they are regularly fed morning and evening, or as often as the feeder finds necessary. Their food is chiefly boiled rice, to which is added the blood of any animals they may kill, wash from their stew-pots and dishes, &c.; indeed, any animal offal or vegetable matter which the fish will eat. Fish so fed and treated advance in size rapidly, though not to any great weight, as the kind (a species of perch) which came under our observation never arrive at much more than a pound avoirdupois; but from the length of three or four inches, when first put in, they grow to from eight to nine in a few months, and are then marketable. Draughts from the pond are then occasionally made; the largest are first taken off, and conveyed in large, shallow tubs of water to market; if sold, well; if not, they are brought back, and replaced in the pond until they can be disposed of. The business of fish-feeding is so managed that the stock are all fattened off about the time that the water is most wanted for the garden crops. The pond is then cleaned out, and the mud carefully saved, or spread out as manure, again filled with water, stocked with young fry, and fed as before. This mode of employing the ground was considered in that country as more profitable than any other.

2097. *The Chinese, likewise, propagate fish* by collecting the spawn in the rivers and lakes where it is deposited, and conveying it in vessels of water to their fish-ponds; this water with spawn is regularly sold by merchants, who make a trade of transporting it from one province to another. It is even said that these ingenious people have a method of hatching the spawn of fish. They fill the shell of a new-laid egg with the gelatinous matter that contains the spawn, wax up the hole through which it was introduced, and put the egg under a sitting hen. At the expiration of a certain number of days they break the shell in water warmed by the sun. The fry are then found hatched, and are kept in pure fresh water till they are large enough to be thrown into the pond with the old fish.

Lately, an account has been published of successful experiments of the same kind having been made by Sir Francis Mackenzie, of Coram-house, Scotland, and others who have reared salmon and trout from spawn taken from the fish, and deposited in beds of gravel laid in ponds; and it is stated by Professor Agassiz that the ova of fish, when properly impregnated, may be conveyed in water of a proper temperature, even across the Atlantic, as safely as if it were naturally deposited by the parent fish.

2098. *The term shell-fish*, though still retained in popular language, is not at present employed by naturalists. It includes the *Crustaceæ*, or crustaceous animals, as lobsters, crabs, shrimps, &c., and the *Mollusca*, or soft animals. Of the Molluscæ, some are covered with a hard outer shell, in one or two pieces, and are named univalves, as the periwinkle, or bivalves, as the oyster; or they are entirely naked, having no shell, as the Medusæ, Sepia, &c. The Crustaceæ contain numerous species and varieties in different parts of the world; but we have only a few in our seas. Animals with shells abound with us, but only a few are large enough to be worth eating. Of the naked Molluscæ none are used in this country as food, though the Sepia or cuttle-fish is eaten in the south of France.

Most shells consist entirely of carbonate of lime (the same as chalk), connected together in layers with a little animal matter resembling albumen; hence shells will burn to a very pure lime. The interiors of many shells are lined with a pearly matter called *nacre*, which is sometimes extremely beautiful, particularly in mother-of-pearl. Pearls, which are found in certain shells, are nothing more than concretions of this substance, which is also carbonate of lime.

2099. *It is said that living too much upon fish* is apt to give rise to cutaneous eruptions; and this Dr. Paris considers as not improbable, particularly in hot climates. The oily

principle upon which the odour of fish depends is absorbed into the blood, when this kind of food is taken, as is evident from the peculiar flavour of sea-fowl that live upon fish. Even the hogs that, in Cornwall, have access to pilchard have often a fishy flavour: and from the sympathy between the stomach and the skin, it is not unlikely that the oily fat fish may have a tendency to produce cutaneous derangement. Thus many facts appear to point out the propriety of changing our food occasionally. It has been conjectured that the priests of Egypt were prohibited from eating fish to avert the leprosy, which was supposed to be induced by living too much upon it; in the same manner that it is thought the Jewish legislator interdicted the use of pork from his belief in its unwholesomeness.

2100. *The supply of fish in the seas round Britain* is not only abundant, but inexhaustible; and yet, notwithstanding this, and the encouragement given by government, the fisheries have not proved so profitable as might have been expected. There is little fish consumed in the interior of the kingdom; and though in London immense quantities are annually made use of, "there can be no doubt," observes Mr. M'Culloch, in his valuable Dictionary of Commerce, "that the consumption would be much greater were it not for the abuses in the trade, which render the supply comparatively scarce, and, in most instances, exceedingly dear." "That this harvest," says Mr. Barrow, "ripe for gathering at all seasons of the year, without the difficulty of tillage, without expense of seed or manure, without the payment of rent and taxes, is inexhaustible, the extraordinary fecundity of the most valuable kinds of fish would alone afford abundant proof. To enumerate the thousands, and even millions, of eggs which are impregnated in the herring, the cod, the ling, and, indeed, in almost the whole of the esculent fish, would give but an inadequate idea of the prodigious multitudes in which they flock to our shores; the shoals themselves must be seen in order to convey to the mind any just notion of their aggregate mass." As the fisheries, and the various circumstances connected with them, are managed at present, the supply of fish is extremely uncertain, which causes a glut at one time, while at another there is scarcely any to be had. The cause of this is obvious. Fish are extremely changeable in their places of resort, and they will leave their accustomed haunts for long periods without our being able to ascertain the reason; nor do we know all the causes of their migration. Fish also require great care in packing and transportation, as they soon spoil. So far it is easy to perceive some of the physical difficulties over which we have no control. But still a question remains, whether all the means are employed which might enable us to enjoy all the advantages of our insular situation, and the abundance with which we are surrounded. But already we see reason to hope that the time is not far distant when the modern improvements will extend to this subject. Before steam navigation, a large proportion of the salmon sold in the London market could not have been brought fresh, and a contrary wind frequently rendered a cargo unfit for sale. By the railways fresh fish will be conveyed daily to inland towns which now receive a supply only two or three times a week, or less frequently. Already the inhabitants of Birmingham have benefited in this respect by the Grand Junction Railway, which gives them access to the Liverpool fish market, and salmon brought to London from Scotland by the steam vessels have reached that place by the same railway. The want of inland conveyances has hitherto deprived the country of the advantage of the extraordinary quantities of fish that have been occasionally caught. Even of cod-fish one ton and a quarter have been taken at a time in one boat. Of mackerel the haul has been sometimes so great that it could scarcely be disposed of, and pilchards and sprats are often obliged to be used as manure for want of sale. The means of conveying these to inland districts must produce, at times, a seasonable supply of food in future.

Sect. II.—Salt-water fish.

Subsect. 1.—*The Turbot* (*Pleuronectes Maximus*, Linn.).

2101. This is the most highly prized of our flat fish. It inhabits the northern and Mediterranean seas, and is taken on the south coast of England in great plenty. It grows to a large size, sometimes even to weigh thirty pounds. The flesh is white, firm, rich, gelatinous, and of a fine flavour; but being a ground fish, Ude, the celebrated French cook, says that it is better for keeping a day or two, since, when just caught, it is apt to be not merely firm, but a little too hard. They are often brought to London alive in well-boats, and, as they do not all spawn at the same time, some are in season in every part of the year. The London market is chiefly supplied by the Dutch fishermen, and a preference is given to those caught on the coast of Holland; but a great many are likewise taken at the Dogger Bank, and on the coasts of Cornwall and Devon. Those sent up from Scotland packed in ice are very inferior, and may be purchased for a fourth of the price given for the best turbots. From the great demand for this esteemed fish, notwithstanding its price, vast numbers are brought to London, so many as 87,958 in one year.

Subsect. 2.—*The Sole* (*Pleuronectes Solea*, Linn.).

2102. The sole is well known to be, next to the turbot, the best of our flat fish. It

inhabits the sandy bottom on all our coasts, but is finer in the west and south than in the north and east. It is an inhabitant of the northern seas, the Baltic, Mediterranean, and America. Great numbers are taken on the south coast of England by the boats from Dover, Folkestone, Brighton, and Hastings, and brought to the London market alive by well-boats or by land carriage. The finest are caught off Plymouth and in Torbay; they frequently weigh eight or ten pounds per pair, and have been seen two feet in length, but the smaller are preferred. They are likewise taken off Yarmouth. They are full of roe at the latter end of February; for a few weeks after, they are soft and watery, but they soon recover. Some of them are in season all the year round; but they are in highest perfection about midsummer. As they are an excellent, firm, white, and delicate fish, they are frequently seen upon the London tables. It is essential that they should be perfectly fresh, or the flesh loses its firmness, and thickness is desirable. Those from the deep water are superior in quality. They have been kept alive in fresh-water ponds; in Mr. Arnold's pond in Guernsey, the sole becomes twice as thick as one of the same length from the sea, and they are known to breed there. They are taken also in the Arun in Sussex, five miles from the sea, where they remain all winter, burying themselves in the mud.

Subsect. 3.—*The Brill* (*Pleuronectes Rhombus*, Linn.).

2103. This is somewhat like the sole, but broader, and is intermediate between that and the turbot. It is a fine fish, and, when large, not much inferior to the latter, though much cheaper. It is brought in abundance to the London market.

Subsect. 4.—*The Flounder* (*Pleuronectes Flesis*, Linn.).

2104. The flounder is generally the least esteemed of our flat fish. It is smaller than the plaice. It inhabits both the seas and rivers, coming into the latter to breed; and they will thrive in fresh-water ponds. It is very abundant on our coasts, and they also frequent our rivers at a considerable distance from the salt water. Great quantities of them are brought to the London market, and are sold at a cheap rate. They are in season from January to March, and from July to September. It is considered as a light food, being sweet and easy of digestion. The Thames flounder is a delicate and esteemed fish.

Subsect. 5.—*The Dab* (*Pleuronectes Limanda*, Linn.).

2105. This is very similar to the flounder, but smaller and thinner. It is out of season in May and June.

Subsect. 6.—*The Plaice* (*Pleuronectes Platissa*, Linn.).

2106. This flat fish is extremely abundant on our coasts, and is also found in the Mediterranean and the Baltic. It is inferior to the sole, the flesh being less firm and white, and not so well flavoured; but when they are of a large size, and just caught, they are by no means despicable. They are sold at a low price, and are generally purchased by the poorer people. The best of those brought to the London market are called *Dowers plaice*, being chiefly caught in the Dowers, or on the flats in the sea between Folkestone and Hastings, weighing from one to five and six pounds. On the coast of Holland they are obtained considerably larger, and are known here as *Dutch* plaice; some of them have been even eighteen pounds. Like all ground fish, they are very tenacious of life, and therefore keep well.

Subsect. 7.—*Halibut* (*Pleuronectes Hippoglossus*, Linn.).

2107. This is the largest of our flat fish, being sometimes found of the weight of two or three hundred pounds, and in the seas of Iceland and Newfoundland much larger. Its flesh is extremely white, and, when small, they are thought by some to be nearly as fine as turbot; but when they are large, the flesh is coarse and dry, and is not much esteemed, having little flavour. In some parts of Scotland this is called the turbot, which often occasions mistakes with the English people. In the London market it appears in March and April, and its flesh is sold in slices by the pound at a low price.

Subsect. 8.—*The common Cod* (*Gadus Morhua*, Linn.).

2108. This is one of the most important of the finny tribe, from the excellence of the food which it supplies, and its prodigious abundance. It is an ocean fish, confined to cold climates, and found only in the northern parts of the world. It is supposed to reside chiefly between the latitudes of 66° and 45°. Those taken north and south of these latitudes are either few in number, or bad in quality. As far north as Greenland they are small and emaciated; and they do not reach so far south as the Mediterranean, where they are unknown. The great resort of this fish is on the banks of Newfoundland, and the other sand-banks that lie off the coast of Cape Breton, Nova Scotia, and New-England, where they find food in the worms produced in these sandy bottoms. They are also taken on the south and west coasts of Iceland, on the coasts of Norway, in the Baltic, and off the Orkneys and western islands of Scotland. The principal fisheries which at present supply the London market with fresh cod are hollows between

the Dogger Bank, the Well Bank, and Cromer on the east coast of England. The fish caught there separates, when cut, in fine large flakes; it is brought alive to London in well-boats. The fishermen seldom find any cod or other round fish on the bank itself, but upon the sloping edges and hollows contiguous to it. The shifting sand on the top of the bank affords them no subsistence; and the shallow agitated water allows them no rest. Inhabiting deep water, they are taken only with lines and hooks. A great deal is caught off Scarborough. They are also taken in great plenty on the coast of Scotland, and the northeast coast of Ireland.

Mr. Yarrell, in his "History of British Fishes," mentions the two principal varieties of cod in the market as *Dogger Bank* and *Scotch* cod. The first has a sharp nose, with the body of a dark-brown colour; the second has a round nose, and the body of a light yellowish ash-green. The first is most esteemed.

2109. *In our seas the cod-fish begins to spawn* in December, and they continue to deposite their eggs on rough, rocky ground till the end of February, when they become poor. Some continue in the roe till the beginning of April: they are, therefore, a winter fish, being in high season about Christmas. They recover from their spawning sooner than any other fish, and it is common to take some cod all the summer. They are amazingly prolific. Leewenhoek counted several millions of eggs in the roe of one cod-fish of middling size, a degree of increase that must render them inexhaustible by human means. They are in highest perfection in the winter, and they keep well; but the glutinous parts about the head, so highly prized by gastronomes, lose their delicate flavour after the fish has been twenty-four hours out of the water. The cod is sometimes found of a very large size, weighing as much as sixty pounds; thirty pounds is not uncommon, but twenty-five pounds is the usual size of a well-conditioned fish; about six or eight pounds is the best for the table; but they are taken of all sizes from that to one pound. When below a pound, they are called *codlings*; the smaller ones are apt to be soft and watery. They are selected by their plumpness and roundness, especially near the tail; by the depth of the pit behind the head; and by the regular appearance of the sides, as if they were ribbed.

2110. The cod is particularly firm and rich when in season, which is known by layers of white curdy matter between its flakes when boiled. It is likewise extremely nutritious and light. When just killed, and in season, the gills are red, the neck thick, the flesh firm, and the eyes bright. The firmness of the fish is much improved by *crimping*. The *milt* of the cod, or soft roe, is brought to table as a garnish, but, from its oily nature, is not fit for delicate stomachs.

2111. *What is called the sound in cod-fish* is the air-bladder, or swimming-bladder, by means of which the fish is enabled to rise or sink in the water. The fish has the power of compressing this bladder; and then the air within it is condensed, in consequence of which its specific gravity, and, therefore, that of the whole fish, becomes heavier than water, and the fish sinks; when it desires to rise, by relaxing the muscles connected with this bladder, it suffers the air within it to be expanded, and the fish becomes specifically lighter than the water, and ascends. The sole, flounder, and other flat fish, have no bladder, and are therefore always at the bottom.

2112. *Cod is brought from the Dogger Bank and other places, and kept alive in the well-boats, or store-boats,* some stout vessels, of eighty or a hundred tons burden, having a large tank for preserving the fish alive. These boats remain as low as Gravesend, because the water there is sufficiently salt; if they come higher up, the fresh water would kill the fish; from the store-boats a portion is sent to Billingsgate by each night tide.

2113. *Cod has been kept in salt-water ponds* in different parts of Scotland, and found to maintain their condition unimpaired. Of these ponds, there is one in Galloway, another in Fife, and a third at Orkney. In these preserves the fish is regularly fed, and sometimes take the food from the hand.

Vast quantities of cod are taken on the Banks of Newfoundland, and brought to us, salted, for an account of which, as well as the other methods of curing fish, by drying, smoking, and pickling, see Book X., "Preservation of Food." By all these methods of curing fish, the digestibility is much impaired, and they are rendered unfit for invalids.

Subsect. 9.—*The Haddock* (*Gadus Æglifinus*, Linn.).

2114. This fish is an inhabitant of the northern seas of Europe; but it is remarkable that it does not enter the Baltic, and is not known in the Mediterranean. It appears on our coasts in December, and is then full of roe. Some are in season from August to February. The haddock resembles the cod in some of its properties. The small ones, when boiled, are less firm than the cod, and rather watery, but the larger fish are firm, and of a fine flavour. In general, they do not exceed the height of ten or twelve inches, weighing two or three pounds, but they are known sometimes to grow to the size of three feet: when large, they are coarse. They are better for being hung up for a day or two, with a sprinkling of salt. They are sometimes cured with salt, and dried; and this is done particularly well at the fishing village of Findhorn, near Aberdeen, by hanging them a day or two in the smoke of peat. *Finnan haddocks* (a corruption of Findhorn),

broiled, are much used at breakfast by the Scotch, and are esteemed a great delicacy. An imitation of these, it is said, may be made by laying the fish in salt for two hours, letting the water drain from them, and then washing them over with pyroligneous acid, and, lastly, hanging them in a dry place for a few days.

Haddocks have been kept in salt-water ponds, or preserves, and will become so tame as to feed from the hand. They are in season during the last three months of the year.

SUBSECT. 10.—*The Whiting* (*Gadus Merlangus*, Linn.).

2115. This fish is tender, delicate, extremely light, and easy of digestion; perhaps the most so of any of our salt-water fish. Whitings appear in large shoals in our seas in the spring, keeping at the distance of about half a mile to that of three miles from the shore, where they appear to come to deposite their spawn. They are taken by the line. Their usual length with us is ten or twelve inches, and they seldom exceed a pound and a half in weight; but on the edge of the Dogger Bank they are found to weigh from four to eight pounds. They are in highest season during the first two months of the year, though they are occasionally taken all the year round. They are not allowed to be caught when less than six inches in length. The spawning season extends from March to September, and towards the end of the year they recover and become good.

In Cornwall, whitings are salted and dried, and in winter sold in the markets under the name of "Buckhorn."

2116. *The whiting pout* (*Gadus luscus*, Linn.) is common about the mouth of the Thames, and generally all round our coasts; it is caught also in the northern seas. It much resembles our whiting, and is an excellent fish. It is most in season in November and December.

2117. *The whiting pollack* (*Gadus pollachius*, Linn.) is caught all round our coasts, and is very common; being somewhat like the whiting, it is sometimes mistaken by the inexperienced for that fish. Its flesh is delicate.

SUBSECT. 11.—*The Ling* (*Gadus Milva*, Linn.).

2118. This fish is an inhabitant of the northern seas, and but little used in Britain as food. The ling in form nearly resembles the cod, but is more slender, and grows to the length of six or seven feet. It is taken in vast quantities off the Orkney, Shetland, and Western Isles, and is found also near the Scilly Isles, and off Flamborough Head. It only inhabits deep water. It is in perfection from February to the end of May; and they spawn in June, depositing their ova in the soft bottom. When they are less than twenty-six inches in length, they are called *drizzles* on the Yorkshire coast, and are consumed at home, being an excellent fish; but when larger they are coarse: they are salted, dried, and exported to Spain and the more southern parts of Europe, where the ling does not inhabit. The sounds and roes are salted separately; and a good deal of oil is obtained from the livers, as well as from those of the cod.

SUBSECT. 12.—*The Torsk, or Tusk* (*Gadus Brosme*, Linn.).

2119. This fish is extremely abundant in the Shetland Islands, where it is called *tusk*. It is a northern fish, found also in Norway and Iceland; but it comes no farther south than the Orkneys, where it is scarce. When fresh, the flesh is hard, and the fish are generally dried, like stockfish, without salt: when soaked in water, and boiled, they constitute the food of a numerous population in the North; but in this state they form a very insipid, though, with strong constitutions, a very wholesome food. They are brought sometimes from Shetland to London with other dried and salt fish.

SUBSECT. 13.—*The Coalfish* (*Gadus Carbonarius*, Linn.).

2120. This is a northern fish, being found in Spitzbergen, Davis's Straits, and the Baltic. It swarms in the Orkneys, where it furnishes a great part of the support of the poor at a certain time of the year; they take it, when under one year old, with rod and line, sitting on the rocks. It is there called the *sillock*: in the second year of its age it comes less frequently to the shore, and is fished from a boat, being named a *cooth*: as it advances in age, it keeps farther out to sea; and, growing to the length of two or three feet or more, it is termed *sethe*; and then it is a very coarse fish. In this state it is split, salted, and dried, for exportation to the Mediterranean. In Edinburgh the young fish are called *podleys*. While under a year old, and till two years, they are a delicate, well-flavoured fish. They can be easily bred in salt-water ponds.

SUBSECT. 14.—*The Mackerel* (*Scomber Scomber*, Linn.).

2121. This is well known to be one of the most elegant in its form among our fish, and the most beautiful in its colours when just taken out of the sea. It was formerly supposed to be migratory, passing the winter in the polar seas, and travelling south every year to deposite its spawn in warmer climates; but the migration of these fish, as well as that of the herring, is now disputed; and most naturalists are of opinion that, during the winter season, it merely retires into the deeper parts of the sea, at a distance from the shores. They appear on our coasts in the spring in immense shoals; but their progress does not correspond with their supposed migration from the north, for they are first met with off the Land's End in March, pursuing a course from west to east, and are found in the bays of Devonshire about April. They are taken off Brighton about April and May,

and on the coast of Suffolk about May and June. In the Orkneys, they are not seen till August. This, instead of being any proof of the supposed migration, rather militates against the opinion that they come from the north.

2122. *Mackerel are so prolific* that 540,000 ova have been counted in one roe. Young mackerel, called *shiners*, are caught in August, from four to six inches long; and they are half grown when they retire to the deep water in November. Their principal food is the fry of other fish, and they are voracious feeders. Their ordinary length is from fourteen to sixteen, and even twenty inches, and their weight a pound and a half to two pounds. The largest fish, however, are not considered the best for the table.

2123. *Mackerel is in great request as an article of food;* but it should be perfectly fresh to be in perfection, and no fish spoils more rapidly: in consequence of its being so perishable a commodity, they are allowed to be cried through the streets of London on Sundays. The common idea respecting mackerel is, that they are in best condition when fullest of roe; but at that time this fish, though not impoverished, has but little flavour. It is in the early part of the season, when the roe is not yet full grown, that they have most flavour. There is likewise an after-season, when, in October, they have had time to fatten and to recover after spawning. Full-grown mackerel are occasionally caught on the Cornish coast all through the year. They are taken with large nets; and in some years the quantity caught is enormous. Mackerel is seldom salted in this country, but it appears that in France they are preserved in that manner. The value of this fish was highly recognised by the ancients, who prepared from it a kind of sause, called *garum*, still made at Constantinople, but now superseded through the rest of Europe by the anchovy. A variety of this fish, called the *Spanish mackerel*, is occasionally taken on our coasts, but it is in no estimation.

The *Scad*, or *Horse Mackerel* (*Caranx trachurus*, Linn.) is a coarse fish, which occasionally appears in vast shoals on the British coasts, particularly the southern. It is rarely brought to market, and not esteemed. In Cornwall it is salted and consumed by poor people.

SUBSECT. 15.—*The Smelt* (*Salmo Eperlanus*, Linn.).

2124. The smelt is a very delicate fish, and much in request. Mr. Yarrell says that the true smelt is almost exclusively confined to the eastern and western coasts of Britain, and that he is not aware of its existence between Dover and the Land's End; what is caught there, and called smelt, being the Atherine or sand-smelt. The smelt ascends rivers and inhabits fresh water from August to May; and, after spawning in March, returns to the sea. It rarely goes far from shore, and is taken in abundance in November, December, and January. It is a very elegant fish: its form is beautifully taper, the skin thin, and the whole body semi-transparent; the scales are small, silvery, and easily rubbed off. It has a peculiar odour, which some compare to that of a cucumber, and others to that of a violet. The Thames used to swarm with this fish; but of late very few have been taken in it. It has been bred in ponds with complete success.

2125. The *Sand-smelt*, or *Atherine* (*Atherina presbyter*, Cuv.), is sometimes sold in Southampton and other parts of the Hampshire coast as the true smelt, to which it is inferior, being more dry; though if dressed with the liver and roe, and without being embowelled, it is excellent. It is plentiful on the south coast of England, where the true smelt is rare.

SUBSECT. 16.—*The Gurnard* (*Trigla Cuculus*, Linn.).

2126. *The Red Gurnard*, sometimes called the *Cuckoo Gurnard*, is very common on the English and Irish coasts. Its head is remarkably well defended with bony plates and spines, and as they swim near the bottom of the sea, they are extremely tenacious of life when taken in the trawl nets. They are an excellent fish as food, and are in greatest perfection in October, though they are to be had through the winter months.

2127. *The Piper* is a species of gurnard, but more rare on our coast than the last. It is chiefly obtained on the western coasts of Devon and Cornwall, and attains the length of two feet, weighing three pounds and a half. All the gurnards emit some sound when taken from the sea; and the name of this species is given from the noise it is supposed to make. Its flavour is thought by some superior to that of the common gurnard.

2128. *The Gray Gurnard* is not uncommon on our coasts. Its general colour is brownish-gray or greenish-gray, the belly silvery white.

SUBSECT. 17.—*Conger Eel* (*Muræna Conger*, Linn.).

2129. This large species of eel is found in the European seas, and sometimes, though rarely, in rivers. It is extremely voracious, feeding on other fish, crabs in their soft state, or dead animals of any kind. It grows to the length of from four to ten feet, and some have been taken weighing a hundred pounds. A fishery of congers, at Mount's Bay, in Cornwall, forms a considerable branch of commerce. They are taken in great quantities, and were formerly exported in a dried state to Spain and Portugal, where, being reduced to powder, they were used for enriching soup. At present they are chiefly sold to foreigners as bait for other fish.

2130. *They are not nearly so oily as the smaller eels*, and the fish being white and firm, they are cooked in a great variety of methods. They make excellent soup, are eaten boiled, broiled, fried, and made into pies.

SUBSECT. 18.—*Skate* (*Raia Batis*, Linn.).

2131. *Of all the larger fish of this country, the skate or ray is the most numerous*, and this is owing, in a great measure, to their size. Only the cachalot and shark have a swallow sufficiently large to receive them, and, perhaps, even they are deterred by their defensive armour. In England some have been taken that weighed two hundred weight, and in other seas they have been met with much larger. In deep water they are supposed to be enormous, for it is only the smaller ones that approach the shores. They are very prolific, one female containing sometimes three hundred eggs; but they produce their young alive, and only one at a time, enclosed in a black, square, horny purse, which are frequently found cast upon the shore after the young skate has come out of it. Like other flat fish, they live at the bottom of the sea.

2132. *The skate belongs to the cartilaginous fishes*, that is, those whose bones consist only of firm cartilage. The flesh is thick, white, and extremely nutritive; and, being easy of digestion, forms an excellent food, less esteemed than it deserves to be. It is much improved by crimping, in which state it is almost always sold in London.

From their great abundance, skate is extremely cheap in the fishing towns of England; and as it is the custom there often to cut out only the best part, and throw the rest away, much excellent nutritious food is lost, which in other places would be converted into use. Skate, likewise, admits of being kept fresh longer than any other fish, and, hung up in the sun, it can be dried without salt. In northern countries, great quantities are thus laid up in store. The French consider skate as a very nutritious and excellent fish, and hold it in greater estimation than it is on this side of the Channel. They send their boats to our fishing towns to purchase skate, particularly in Lent, and they preserve it fresh by keeping it covered with wet sand. Skate are taken in abundance all round the coasts of England and Scotland.

There are several species found in our seas besides *Raia batis*, or true skate, as the *long-nosed skate*, the *white skate*, and the *Homelyn ray*, which are of inferior quality, though often crimped and sold for true skate.

2133. *Skate gets in season* in July, and continues so through autumn and the beginning of winter, but is not good in spring or early summer.

2134. *The Thornback differs from the true skate* in having large spines in its back, which are wanting in the latter. It does not grow to the size of the skate, and is considered as rather inferior in quality; in other respects it is very similar. The thornback is taken in greatest abundance during spring and summer, because then they approach nearest the shore for the purpose of spawning; but their flesh is not so firm and fit for the table at this season as in November. The fishermen call the females *Maids*.

SUBSECT. 19.—*Striped Red Mullet* (*Mullus Surmuletus*, Linn.).

2135. The colour of this fish is an elegant rose-red tinged with olive, when on the back, and a silvery coat on the abdomen. They occur frequently on the Cornish coast, and are taken also on the coast of Sussex, but become rare more north. This fish was held in great esteem by the Romans, not only on account of its delicious flavour, but also from its beautiful colour. At present it is a fish in high request, the flesh being white, firm, and of a fine flavour. On our coasts it seldom exceeds fourteen inches in length. Mullets occur sometimes in profusion, and at other times are exceedingly scarce; they are mostly taken with trawl nets, which traverse the bottom of the sea. They appear in the fishmongers' shops nearly throughout the year, but most frequently in May and June, when they are in best condition. Notwithstanding that the usual habitat of this mullet is the sea, it occasionally ascends rivers.

SUBSECT. 20.—*Gray Mullet* (*Mugil Capito*, Cuv.).

2136. The gray mullet, though bearing the same name, is altogether a different fish from the red. It is very plentiful on the sandy coasts of our island, and is observed to assemble in small shoals near the shores in the spring in quest of food, burrowing into the soft mud for worms, and leaving the trace of its head in the form of a round hole. Unlike the salmon, they spawn in the sea; but, like that fish, they ascend rivers for miles. When preparing for these expeditions, they are observed in shoals near the surface of the water, at which time the fishermen endeavour to avail themselves of the opportunity of surrounding them with their nets. The mullet is particularly abundant on the southeast coast of England. It is considered a fine fish; and the spawn is sometimes made into an inferior kind of caviare, by drying and salting it. From its partiality to fresh water, this fish has been thought favourable for the experiment of keeping marine fish in fresh-water ponds; and, accordingly, Mr. Arnold, of Guernsey, has fattened them prodigiously in this manner. Of all the salt-water fishes so introduced into ponds, the gray mullet seemed to be the most improved.

SUBSECT. 21.—*The Herring* (*Clupea Harengus*, Linn.).

2137. This excellent fish is peculiar to the northern seas, and is well known to supply abundance of food, particularly to the poorer classes. The name *herring* is derived from the German *heer*, an army, which expresses the number they appear in. Herrings are met with in great plenty, from the highest latitudes, as low as the northern coast of France. They are also found in vast shoals on the coast of America, as low as Carolina; and they are met with in the Sea of Kamtschatka.

2138. *The herring was supposed to be a migrating fish*, and that its chief rendezvous is the icy sea within the arctic circle, which swarms with insect food in greater abundance than warmer latitudes. Pennant and other authors have described the migration of the herring in a very circumstantial manner, which has been copied into numerous publications.

Notwithstanding the almost universal belief, however, of the migration of the herring from the northern regions to the south of Europe, and the detailed description of it, yet some of the best naturalists of the present day consider these accounts to be in most instances erroneous, and think it most probable that the herring, like the mackerel and the sprat, during the winter months inhabit the deepest parts of the sea, but at no great distance from the shore, or plunge beneath the soft mud at the bottom, from whence they rise in the spring season, and approach the shallower water, in order to deposite their spawn. It is thought that the northern migrations supposed by Pennant and others are impracticable in the short period assigned to them, as the fish, in its swiftest progress, is utterly incapable of moving at a rate so rapid as the term allowed for those migrations would require. Many interesting facts and observations on this subject may be found in Dr. M'Culloch's "Description of the Western Islands of Scotland." That they do move about in wandering shoals, like many other fish, is certain; but what renders it improbable that they come from the polar regions, as has been imagined, is, that they have not been observed there by our navigators. Their movements appear to be extremely capricious; for many of the deep bays of the west of Scotland and Ireland, which they frequent at one time, are entirely deserted in another year without any obvious cause: a circumstance which sometimes proves ruinous to the inhabitants of fishing stations.

2139. *Besides the great quantities of this fish consumed at home in a fresh state, much more is cured with salt and exported.* It has been stated that the Hollanders were the first who began the fishery of herrings on an extensive scale, and observed the several seasons of their passage, about 1163; but it is recorded in the Batavian annals that the Scotch sold their herrings to the inhabitants of the Netherlands as early as the ninth century; and this traffic laid the foundation of a commercial alliance between the two countries which subsisted for many ages. The Yarmouth fishery appears to have had its commencement soon after the landing of Cerdic, the Saxon, in 495, and the inhabitants of the town were long considered as the best curers in Europe. They had an advantage over the Dutch in being nearer to the herring shoals, and in possessing plenty of wood to smoke them, which is extremely scarce in Holland.

Willoughby, in his "History of Fishes," ascribes the art of curing herrings by salt to William Beukelz, a Fleming, who died in 1397; and the term *pickling* is supposed to be derived from him. Yarmouth, however, puts in a prior claim to this art. It is recorded that, in 1290, the Abbot of St. Alban's purchased a large house in Yarmouth, "in order to lay up fish, especially herrings, which were bought by his agents at the proper season for the use of the abbey." Prior to 1238, the inhabitants of the opposite coast of Europe were in the habit of resorting to Yarmouth for a supply of this fish. These and other recorded facts show that the method of preserving herrings, probably by salt, must have been known in England more than 200 years before Beukelz.

2140. *The principal British herring fisheries are on the west and east sides of Scotland and the west of Ireland;* the herrings fished in England are comparatively inconsiderable. Yarmouth and Lowestoffe are the principal places; and very large quantities are also caught at the mouth of the Thames by the fishing smacks of London, Folkestone, Dover, &c., for the London markets, and near the coast of Kent and Sussex for general consumption.

2141. *As food*, fresh herrings, though rather oily, form a very good aliment if used moderately; but that is not the case with pickled and salt herrings; these are only fit for those whose powers of digestion are very strong: in small quantities, with plenty of potatoes or other vegetables, they are less objectionable. Red herrings are used less as food than as a luxury. They excite thirst, and tend to create fever.

For the methods of curing herrings, see Book X., "Preservation of Food."

SUBSECT. 22.—*The Pilchard* (*Clupanodun Pilchardus*, Linn.).

2142. *The pilchard is somewhat allied in general appearance to the herring*, but is thicker, or of a less compressed form, the back more elevated, and the scales much larger in proportion. It is also a smaller fish than the herring, but larger than the anchovy, rarely exceeding the length of eight inches. Its geographical distribution is much more limited than the herring; instead of being found on every part of the British coast, like that fish, it occurs in this country in great numbers only on the shores of Devon and Cornwall. It likewise requires a warmer climate than the herring, abounding in the Mediterranean, and the coasts of Dalmatia, from which Greece and Italy are partly supplied. Pilchards appear usually in vast shoals off the Cornish coasts about the middle of July, and disappear in the beginning of winter, though a few return again after Christmas. Their winter retreat is supposed to be the same as that of the herring, in the deep sea.

2143. *The pilchard fishery is a very productive concern on the coast of Cornwall*, where these fish are cured with salt for exportation. Their appearance on the coast, and their term of remaining, are irregular; but when they come, they often appear in shoals so large and dense as almost to exceed belief. The shoals, either when pursued by enemies, or from other causes, crowd occasionally into bays and harbours in enormous quantities. In 1767 there were taken in St. Ive's Bay 3000 hogsheads of pilchards, each hogshead containing 3500 fish; at another time 10,000 hogsheads were caught at one time.

In Cornwall, besides the great number of persons employed in the fishery, and curing fish with salt for exportation, the poor are fed by them, and a large quantity is generally left, sufficient to supply a valuable manure for the land. The pilchard is a fat, oily fish, more so than the herring, and oil is extracted from them; but the Cornish people, nevertheless, use them as food, and many prefer them to the herring. They make a pilchard pie in the following manner: They clean the white part of some large leeks, scald them in milk and water, and place them in layers in a dish, putting between each layer two or three salted pilchards which have been soaked for some hours the day before; the whole is then covered with a good plain crust: on taking the pie out of the oven, the side crust is lifted up with a knife, and all the liquor being emptied out, its place is supplied with half a pint of scalded cream. Pilchards are not brought to London as such, but the young fry are often sold for anchovies.

SUBSECT. 23.—*The Sprat* (*Clupea Sprattus*, Linn.).

2144. This well-known little oily fish never grows to a larger size than four or five inches in length. It is a wandering fish, visits our shores, and continues with us in large shoals, when the herring and other fish have retired to the deep. They enter the River Thames below bridge about the beginning of November, and leave it in March; and being sold at a low price, are, during their season, a great relief to the poor of the capital. At Gravesend and at Yarmouth they are cured like red herrings. They are sometimes pickled, and, when managed properly, are little inferior in flavour to the anchovy, but the bones will not dissolve like those of the latter. In Cornwall the true sprat is very rare; what has been so called is the young of the pilchard. The coasts of Kent, Essex, and Suffolk are the most productive of them. There from 400 to 500 boats are employed during the winter; and, besides the immense supply to the inhabitants of London, many thousand tons are sold at from sixpence to eightpence per bushel to farmers, who employ them as manure to the land, distributing about forty bushels over an acre; they have even been sent up the Medway to manure the hop grounds in Kent.

SUBSECT. 24.—*White Bait* (*Clupea Alosa*, Linn.).

During the month of July there appears in the River Thames, near Blackwall and Greenwich, innumerable multitudes of small fish, which are known to the Londoners by the name of *white bait*. They are esteemed very delicious when fried with fine flour, and occasion, during the season, a vast resort of persons to the taverns contiguous to the places where they are taken. There were various conjectures about this fish; and though most of them terminated in a supposition that they are the fry of some fish, few agreed to which kind they owe their origin. Some attributed them to the shad, others to the sprat, the smelt, or the bleak. Mr. Donovan, in his "History of British Fishes," states that he had ascertained, past all doubt, that the white bait is the fry of the shad. Mr. Yarrell, however, in his late work on fishes, contests this opinion, and maintains that the white bait is a species distinct from every other fish. It is supposed that the parent fish are not taken, from not coming up high enough in the river. While it was supposed that white bait was the fry of other fish, and that using small nets for taking them was destructive to these fish, such nets were forbidden to be employed; but now that the subject is supposed to be better understood, the fishermen resume the use of these nets without any notice being taken of it, and white bait are commonly sold in London.

SUBSECT. 25.—*The Shad* (*Clupea Alosa*, Linn.).

2145. *The shad* is a sea fish that enters our rivers in May in order to spawn; and this accomplished, it returns to the sea by the end of July. Great numbers are taken opposite the Isle of Dogs in the Thames, but they are in little repute. The usual size is about twelve inches in length.

SUBSECT. 26.—*The Anchovy* (*Clupea Enchrasicolus*, Linn.).

2146. The little fish called anchovy is less used with us as food than as affording an agreeable relish, or for sauces and seasonings. It bears a considerable resemblance to the sprat; and its general length is from three to four inches, or, at the utmost, about four inches and a half. It is found in greatest plenty in the Mediterranean, but also in the Northern and Atlantic seas; and, like the herring, is supposed to leave the deep recesses of the sea, approaching the shores in spring for the purpose of depositing its spawn. The great fishery of anchovies is at Gorgona, a small isle to the west of Leghorn; and they are likewise caught in the Zuyder Zee in Holland, where their fishing is a very profitable branch, and many thousand barrels are annually cured at Amsterdam, Monickendam, &c., for exportation. They are taken in vast quantities, and prepared for sale by salting and pickling; they are put into salt as soon as they are taken, while still alive. The bones dissolve in boiling. The anchovy has been observed (and Mr. Yarrell says more frequently than is usually supposed) on the English coast. It is stated by Mr. Crouch that the anchovy abounds on the Cornish coast towards the end of summer, and that sufficient might be procured to supply Great Britain if attention

were directed to the fishery in October and November. Anchovies should be chosen small, fresh pickled, white outside, and red within. Their backs should be round, not flattened. The head, being bitter, is removed in pickling.

2147. The *sardine* is a fish so called in the Mediterranean, flatter in the back and larger than anchovies, and is frequently substituted for them; but it is much inferior to the real anchovy; it is said by some naturalists that the sardine is no other than a small pilchard.

2148. *It is known that many adulterations are practised with anchovies* in England, such as putting anchovy liquor upon pickled sprats or pilchards; and as the red colour is considered essential, red-lead, a poisonous substance, has been employed to colour it; others colour them with cochineal, or red bole. It will be prudent, therefore, to procure anchovies fresh as they come over from Gorgona, and to take care that the flesh itself is red, which is not the case with the sprat. Anchovies are offered for sale in London at the rate of 30*s.* the double barrel, of 38 to 40 lbs., or 16*s.* the single barrel. They will keep long if covered with brine, but soon spoil if exposed to the air.

2149. *Essence of anchovies* is most liable to be adulterated. It may be made in the following manner: Take three pounds of anchovies, pulp them through a fine hair sieve; boil the bones with salt and water, seven ounces of salt to six pints of water; strain, and add seven ounces of flour; then pass the whole through a sieve. This should produce one gallon of the essence. No colouring pigment should be added, though this is directed in most of the receipts; all of them spoil the flavour of the anchovy. The addition of lobsters' eggs will, however, not only be harmless, but will improve the flavour, and, says the "Cook's Oracle," is the only rouge to be recommended.

Subsect. 27.—*The Doru, or John Dory* (*Zeus Faber*, Linn.).

2150. This fish is probably so named from the French *dorée*, gilded, in consequence of its golden-yellow colour. It is a rare fish in general, though sometimes taken in profusion on the Cornish and Devonshire coasts: the average weight is about five pounds; but some specimens sent to the London market have been twice as much. It appears to be a wandering fish, and is in high estimation for the table: the flesh, when dressed, is of a clear white. Most of those purchased in London are brought by land-carriage from Plymouth and other parts of the Devonshire coast. Being a ground fish, they are not the worse for keeping till the second or third day. When fresh caught they are tough.

Subsect. 28.—*The Sturgeon* (*Accipenser Sturio*, Linn.).

2151. This is one of those fishes that migrate from the sea to fresh water: the former serves for its production; but it never goes to any great distance from land, and it is only in large rivers that it grows to its usual size. It is found in the ocean, in the Baltic, the Mediterranean, Black Sea, Caspian, and in prodigious numbers in the large rivers which flow into them. The greatest sturgeon fishery is at the mouth of the Volga, in the Caspian Sea. This fish is likewise abundant in the rivers of North America, and there are regular fisheries in the River Garonne, on the coast of France: occasionally it is taken in the Thames, and is one of those fishes considered as only royal property. The rivers Eske and Eden afford large sturgeon; the form of the fish is lengthened and slender, with a long, projecting snout; its body is defended by hard scales and bony tubercles; the mouth is small, placed beneath, and is without teeth. It is a very strong, vigorous fish, grows frequently to the length of five or six feet, continuing to grow as long as it lives, and has been known to attain the length of twenty feet. Those brought to the London market commonly measure from four to eight feet, and sometimes weigh nearly 300 pounds. Notwithstanding its size, it is said to be of a mild character, feeding on small fish and worms. It is extremely fertile, one fish containing 300,000 eggs.

2152. *It belongs to the class of fishes whose bones are entirely cartilaginous*, and its flesh is much esteemed, being delicate, firm, and white as veal, which, indeed, it resembles so much, that slices of sturgeon, dressed in the manner of veal cutlets, are scarcely to be distinguished from them but by a superadded flavour somewhat like that of the scallop shell-fish. Sturgeon pies are much like meat pies; the flesh is sometimes roasted on a spit, like meat, and is excellent stewed with gravy, and made into soup. Sturgeon is rare in the London market, where it sells for 1*s.*, or 1*s.* 6*d.* per pound. Its season is the winter and spring. As it can seldom be had fresh with us, it is brought pickled from the Baltic and North America: those cured at Pillau are the best.

The sturgeon was in high repute among the Greeks and Romans, and Pliny states that it was brought to table with great pomp, accompanied with music, and ornamented with garlands of flowers.

2153. *Caviare* is a favourite food of the Russians, prepared from the hard roes of the sturgeon chiefly; the roe is cleaned from the strings and fibres, steeped in strong brine, or salt pickle. It is then dried, and pressed into casks or tubs, and formed into small cakes about an inch thick, and three or four inches in breadth. The red caviare is salted and smoked. The fishery of the sturgeon, for this purpose, is extremely profitable to

those engaged in it, and likewise to the government of Russia. Caviare is used by that nation as an article of food in the long Lent of the Greek Church, and on the fast days, which they observe with great strictness: it is exported for the same purpose to Italy and Germany. It also finds its way occasionally to the English table. It has lately been brought nearly fresh to London, in the same state as it is used at Riga and Petersburgh, and may be had at Mr. Ball's Italian warehouse, New Bond-street, at fifteen shillings per cask of three pounds. To be good, caviare should be of a reddish-brown colour, and very dry. It is eaten alone, or with oil and lemon, or vinegar, or with a sauce and pickle, like anchovies. The best caviare, as well as the best isinglass, is made by the Cossacks on the River Ural. In winter the roe is eaten fresh, and it is reckoned that the less salt put with it the better; but without some it will not keep.

2154. *The Sterlet* is a smaller species of sturgeon, seldom exceeding the length of three feet. It is found in the Caspian Sea, and in some of the Russian rivers, and is highly celebrated for the delicacy of its flesh. It is recorded of Prince Potemkin of Russia that, in seasons when the sterlet was unusually scarce, he had been known to have given three hundred rubles for a tureen of sterlet soup. The caviare prepared from the roe of the sterlet is a dainty still more expensive, and is said to be almost exclusively confined to the use of Russian royalty.

SUBSECT. 29.—*The Tunny* (*Thynnus Vulgaris*, Linn.).

2155. This fish rarely appears upon the English coast; but abounds in the Mediterranean, and is occasionally taken among the western isles of Scotland. It is a large fish, three or four feet in length, and sometimes much more. The flesh is considered very delicious, and something between fish and meat; it is as firm as sturgeon, but finer flavoured. In France it is much used, and dressed in a great variety of ways.

SUBSECT. 30.—*The Sea Lamprey* (*Petromyzon Marinus*, Linn.).

2156. The lamprey is a singular fish. In its general appearance, it approaches the eel tribe, and is distinguished by seven holes, like shot holes, on each side of the head, which are breathing holes. The generality of British specimens are from twenty to twenty-eight inches in length. This fish is an inhabitant of the ocean, ascending rivers chiefly during the latter part of winter and the early months of spring, and, after a residence of a few months in fresh water, it again returns to the sea. When in motion, it is observed to swim with considerable vigour and rapidity; but it is more commonly seen attached by the mouth to some large stone or other substance, the body hanging at rest, or obeying the motion of the current: so strong is the power of adhesion by this animal, that a stone of the weight of more than twelve pounds may be raised without forcing the fish to forego its hold. Like the eel, it is remarkably tenacious of life: the several parts, when cut in pieces, will long continue to move, and the head will strongly attach itself, for several hours, to a stone, though the greater part of the body be cut away from it.

The lamprey belongs to the class of fishes whose bones, instead of being hard, are mere cartilage; its spine is quite soft, without any protuberances. For many ages it has maintained its credit as an exquisite dainty, and has uniformly made its appearance at the most splendid of our entertainments. The death of King Henry I. is attributed to a too luxuriant indulgence in this his favourite dish. It still continues to be in high esteem, and we are told by Mr. Pennant that the city of Gloucester continues to send yearly, at Christmas, a present of a rich lamprey pie to the king. It is, notwithstanding, by some considered not to be wholesome food. Lampreys are most in season during March, April, and May, and are observed to be much more firm when just arrived from sea than when they have been a considerable time in fresh water. They are found in several of the British rivers, but that which is the most celebrated for them is the Severn. In the mouths of the larger of the European rivers they are sometimes taken in such quantities that it is impossible to use them in their fresh state; they are, therefore, grilled and moderately salted, and afterward barrelled up for sale, with the addition of vinegar and spices, or potted. Lampreys are dressed in several ways; they are boiled, roasted, fried, baked, in pies, or salted and dried for keeping.

2157. *The River Lamprey, or Lampern* (*Petromyzon fluviatilis*, Linn.). This species is smaller than the last, and though found chiefly in the rivers, likewise visits the sea. It is caught in considerable quantities in the Thames, the Severn, and the Dee. It is more plentiful than the greater lamprey.

SUBSECT. 31.—*The Weaver*.

2158. *The great weaver*, or the *sea cat* of Sussex, generally measures about twelve inches in length, swims near the bottom, and is remarkable for living a long time after it is taken out of the water. It is also armed with very sharp spines, which inflict wounds difficult to heal, except friction with oil be used. The fishermen, consequently, cut off these spines previous to bringing them to market. They are a sort of marine perch, and are excellent.

2159. *The lesser weaver* is more common on our coasts than the great weaver, and, having the faculty of striking with its sharp spines, is often called the *sting fish*.

SUBSECT. 32.—*The Wolf Fish, or Sea Cat* (*Anarrhichas Lupus*, Linn.).

2160. This is almost exclusively a northern fish, taken in the north of Europe, the Orkneys, and the coasts of Yorkshire and Norfolk. It has a ferocious-looking head, resembling a cat, and is furnished with strong teeth, with which it inflicts severe wounds. It does much mischief to the fishermen's nets. Those who have eaten it describe it as delicious; but few can overcome the prejudice excited by its appearance. The skin is very thick and strong, and is converted by the northern people into very durable bags.

SUBSECT. 33.—*The Bass.*

2161. *The bass* is a marine perch, found along the whole line of the southern coast of England, and in the Bristol and St. George's Channels; also occasionally on the coast of Scotland. The ordinary size of this fish is from twelve to eighteen inches in length, though it sometimes attains fifteen pounds in weight. They feed upon small fish and crustaceæ, and are caught by angling as well as the net. On the Kentish coast they are known by the name of *sea-dace*. They generally spawn near the mouths of rivers, and live very well in Mr. Arnold's fresh-water lake in Guernsey. They are fish of a good flavour, although by some reckoned coarse.

SUBSECT. 34.—*The Sea Bream* (*Pagellus Centradontus*, Cuv.).

2162. This is not an uncommon fish on the south coast of England, and may be frequently seen during the summer in the fish-market of Hastings: they are abundant in Cornwall. The young are commonly known by the name of *chads*, and it is said that the fish spawns twice in the year. It is not much in esteem for the table. Mr. Yarrell recommends the following as the best mode of dressing the sea bream: "When thoroughly cleaned, the fish should be wiped dry, but none of the scales should be taken off. In this state it should be broiled, turning it often, and if the skin cracks, flour it a little to keep the outer case entire. When on table, the whole skin and scales turn off without difficulty, and the muscle beneath, saturated in its own natural juices, which the outside covering has retained, will be of good flavour."

SUBSECT. 35.—*The Lump Sucker* (*Cyclopterus Lumpus*, Linn.).

2163. This fish is sometimes seen at the fishmongers', hung up as a curiosity. It is eatable, but has no particular good quality.

SUBSECT. 36.—*Dog Fish* (*Squalus Canicular*, *S. Catulus*, Linn.).

2164. These fish belong to the shark tribe, and several species abound on our coasts, where they are very destructive to the fish, being extremely voracious. They are taken frequently in the nets with other fish, but are seldom used as food, being very full of oil, and strong tasted; nevertheless, in the northern parts of the kingdom, as in the Orkney and Shetland Islands, they are dried in the smoke, and even looked upon as dainties by the poorer sort of inhabitants.

SUBSECT. 37.—*The Whale.*

2165. The whale being the largest of all animals, we might suppose that its flesh is too coarse for food; that, however, is not the case. This animal, being one of the *mammalia*, suckling its young with milk, and breathing air without separating it from the water by means of gills, is not properly a fish, and its flesh is much like beef. Parts of the animal, particularly about the tail, are said not to be contemptible as food even by those who are not pressed by hunger; and some species, as the spermaceti whale, are very generally consumed by the Greenlanders, and other inhabitants of the arctic regions.

SUBSECT. 38.—*The Porpoise.*

2166. The porpoise was once a favourite at the tables of the great in this country, and was eaten with a sauce composed of vinegar, bread-crumb, and sugar. The flesh of the young has been compared to veal; but at present, instead of its being "food for kings," not a beggar will touch it.

SUBSECT. 39.—*The Dolphin.*

2167. The dolphin, though celebrated by the poets for its gambols, does not appear to be at present as much valued as formerly, when we read of an English feast consisting of a "roasted dolphin with proper sauce."

SECT. III.—FRESH-WATER FISH.

SUBSECT. 1.—*The Salmon* (*Salmo Salar*, Linn.).

2168. The salmon is styled by Walton, the celebrated angler, "*king of fresh-water fish.*" It is to be found all over the north of Europe and Asia, from Britain to Kamtschatka, but never ventures into the warm latitudes: it has been met with on the coasts of Greenland, and has been seen in some of the rivers of France, but none have been caught so far south as the Mediterranean.

2169. *It is a migratory fish*, and annually ascends rivers in large shoals for the purpose of spawning; but it is only to be found in such rivers as communicate with the sea, in consequence of which it is by some considered as a sea fish. The Romans were well acquainted with it, and our English name is borrowed from their salmo. The long migration of the salmon just before the spawning season forms an interesting part of their history.

It is certain they receive the principal part of their food in the sea, but it appears that the ova or eggs can only be hatched, and the young fish live, in fresh water; in the early period of a salmon's existence, salt water being fatal to it: also, that the causes of the alternate migrations of salmon are the impulse of propagation, and the search after food. In their debilitated condition after spawning, when they are "out of season," they betake themselves to the deep sea in which their haunts are not known.

Having recovered their vigour, they crowd in shoals towards the coast, and roam about in the estuaries until the autumnal floods entice them to enter the rivers. While thus detained on the coast and in the estuaries, they are pursued and preyed upon by numerous herds of seals and grampuses, which consume many more than fall to the lot of the fishermen. The early run fish are in good condition, the roe being still small, and they then mount towards the higher and more distant branches of the river.

In ascending the rivers they not only make their way against the most rapid currents, but overcome obstacles that might be supposed insurmountable. When they arrive at a waterfall or a weir, they leap out of the water to get over it. The salmon leap at Leixlip, on the Liffey, is thirty feet high. When there is little water in rivers they cannot ascend, and are obliged to take advantage of freshets. Towards August and September the roe has acquired such a size as to render the fish nearly useless as food, and greatly to limit the extent of its migrations.

Having arrived at a suitable spawning-ground, for which they prefer a gravelly bottom, the salmon pair, and proceed to the shallow pebbly fords at the top and bottom of pools, and then, in company, make their spawning bed, which sometimes reaches from twelve feet in length to ten in breadth. This bed is furrowed by the parent fish working up against the stream, and the spawn is deposited and covered at the same time. This process frequently occupies more than a week, during which the eggs deposited by a single fish sometimes amount to the astonishing number of 20,000! This spawning season extends from the end of October to the beginning of February, and occurs nearly about the same time throughout all the rivers of the United Kingdom; and during this period salmon is wholly unfit for food.

The parent fish, having thus accomplished the important purposes of their migration into the river, now retire into the deepest pools, were, after remaining a considerable time, they direct their course towards the sea, chiefly during the months of February, March, and April, the male fish appearing to migrate earlier than the females.

The eggs of the salmon remain in the gravel for several months, exposed to the influence of running water; and in the course of the month of March the fry are hatched. At first they are less than an inch in length; but upon leaving the spawning bed they betake themselves to the neighbouring pools, where they speedily increase to two or three inches. They then appear in incredible numbers, and descend to the sea in April, May, and June. It is said that, on first meeting with the tide, they remain some days in the brackish water till they get inured to the change.

At different periods of their progress the young fry have received different names, and there have been doubts whether they all belong to the salmon or to other fish. When under two pounds' weight they are called by some London fishmongers *salmon peel*; and when larger, but under a year old, they are termed *grilse*. These fish of the year breed during the first winter, and return from the sea next spring with the roe enlarged, as has been described, for the purpose of spawning, accompanied generally by the parent fish, when the season of fishing commences, and they are considered to be best as food prior to their entering the fresh water.

Thus the salmon passes the summer in the sea or near the mouth of an estuary; in autumn they push up rivers; in winter they inhabit the pure fresh water; and in spring descend again to the sea. From their regular change every year from salt water, it might be supposed that they could not be bred and kept altogether in a fresh-water lake. The experiment has, however, been tried with success, but it is said that the fish is inferior in flavour to those which have access to the sea.

2170. *When the salmon is in the sea, and about to enter the rivers for the purpose of spawning, or shortly after entering the rivers, it is in the highest perfection*; the flesh is firm and of a fine red colour, and the flavour excellent. The sides are of a bright silvery hue, with few dark spots: great numbers are caught at that time.

When the fish has spawned and is returning to the sea they have fallen off in condition; the colour has become dull, and the sides are streaked all over with red and dark spots; the rays of their skin are jagged and torn, part of their scales are torn off, and their gills are sometimes infested with parasitical fresh-water worms, which stick to them, and which they get rid of in the sea. At this time they are not wholesome, and are supposed to be productive of disease. This circumstance, however, is not sufficient to prevent those who have an opportunity from catching and eating the fish in that state: and the legislature has found it necessary to fix the periods at which salmon fishing is lawful. When they first arrive at the rivers from the sea, an insect, called the salt-water louse, is found adhering to their sides, and is a proof that the fish is in season. Although this subject has excited so much interest, and been so carefully studied, yet so difficult is it to acquire an accurate knowledge of fish, that the habits of the salmon are still involved in some obscurity. It has been said that every salmon, when wishing to return to fresh water after having been in the sea, goes up the same river in which he was spawned, and that each river has its own fish; but this is improbable: perhaps each fish may prefer his own river, but that he can find it always is unlikely.

The salmon is a voracious feeder, and its food consists of small fishes and marine a-

sects. It increases rapidly in size while in the sea, where it finds the greatest abundance of food.

It is thought that the breed of salmon is decreasing in Britain, from the amazing number that are killed in ascending to spawn, and from the want of protection of the fisheries.

2171. *The chief salmon fisheries in Europe* are along the coasts of England, Scotland, Ireland, and the Baltic. The fish is generally taken by nets, and also in the rivers, by a kind of locks called *weirs*. Near Whitehaven they are also speared. As they are caught in rivers and estuaries, the salmon fisheries are chiefly private property. The consumption of this fish in the metropolis is immense, and the London market is supplied principally from the rivers of the northern part of the island. Formerly salmon was caught in the Thames in abundance, and this was reckoned the finest; but since the water has been deteriorated by numerous sewers and gas works, this fish no longer frequents the river. The salmon of the Severn and Wye is excellent, and is first in season of any in England. Formerly such part of the salmon of the North as could not be consumed at home was pickled and kitted after being boiled, and was in this state sent up to London, under the name of Newcastle salmon. Within the memory of many now living, salted salmon formed a material article of household economy in all the farmhouses in the vale of the Tweed; insomuch that in-door servants used to stipulate that they should not be obliged to take more than two weekly meals of salmon. Its ordinary price was then 2*s*. a stone of 19 lbs. At present an immense quantity is taken in the Tweed, and is sent to London by the Berwick smacks. The fishing in the Tweed begins on November 30th, but there are few taken till after Christmas; and it ends at Michaelmas. Salmon, like all fish that swim near the surface of the water, cannot be eaten too fresh; its fine flavour diminishes rapidly after capture.

2172. *About the year 1788 the method was first resorted to, now so much practised, of packing salmon in ice to preserve it*, which enables the proprietors of the fisheries at a distance to send it to London in a fresh state; and salmon preserved in this manner is now despatched in fast-sailing vessels from the Spey, the Tay, the Tweed, the Dee, and other rivers of Scotland. This has amazingly altered the price of the fish, and increased the value of the fisheries. Icehouses are now built at the several rivers, to keep the fish in until the time for sending it arrives. A great deal of fish is often spoiled by this mode, and the flavour is materially injured by freezing. There are also salmon fisheries in some of the English and Irish rivers, but inferior to those of Scotland. The price of salmon in the season in London is frequently as low as 9*d*., and even 6*d*., per lb.

2173. *Salmon is cured or preserved* in various ways: salted or pickled, and dried. For the method of pickling salmon, see Book X., "Preservation of Food."

2174. *As food*, salmon, when in high perfection, is one of the most nutritive and delicious of our fish; but as it is very oily it is rather heating, and with some persons not very digestible; with most constitutions it requires the addition of condiments, as Cayenne pepper and vinegar. It is thought by some that the addition of shrimp, lobster, and other rich sauces, with which it is usually eaten, increases its indigestibility; but there does not appear to be any distinct knowledge on this subject, so much depending upon peculiarity of constitution. It requires to be very well boiled, otherwise it is unwholesome; and when in the best condition and season, it has a fine curdy matter between the flakes, which is a proof of its perfection, and the flavour is then very much superior; but this is seldom seen except near to the places where it is caught, as it melts away in keeping.

2175. *When the salmon runs from six to ten pounds* they are very good fish, and make handsome dishes sent to table whole; but by a late act of Parliament no salmon is permitted to be sold by the fishmonger of less than 6 lbs. weight, to prevent the destruction of the breed.

2176. *We find the following account of the perfect mode of cooking the fish* in Sir Humphrey Davy's "Salmonia:" "We must now prepare him for the pot. Give him a stunning blow on the head to deprive him of sensation, and then give him a transverse cut just below the gills, and crimp him by cutting to the bone on each side, so as almost to divide him into slices; and now hold him by the tail that he may bleed. There is a small spring, I see, close under that bank, which, I dare say, has the mean temperature of the atmosphere in this climate, and is much under 50°; place him there, and let him remain for ten minutes, and then carry him to the pot, and let the water and salt boil furiously before you put in a slice, and give time to the water to recover its heat before you throw in another, and so with the whole fish, and leave the head out, and throw in the thickest pieces first."

The rationale of this process of crimping is thus given: "I conclude that the fat of salmon between the flakes is mixed with much albumen and gelatin, and is extremely liable to decompose, and by keeping it cool the decomposition is retarded, and by the boiling salt and water, which is of a higher temperature than that of common boiling water, the albumen is coagulated, and the curdiness preserved. The crimping, by preventing the irritability of the fibre from being gradually exhausted, seems to preserve it so hard and crisp, that it breaks under the teeth; and a fresh fish not crimped is generally trout."

Salmon crimped in this manner, which preserves the natural taste, should have no other sauce than a spoonful of the salt and water in which it has been boiled, with the addition of a little lemon juice (or, if that cannot be had, vinegar) and pepper. Some persons, however, object to the curdy state of the fish, and prefer it when it has been kept for a day or two, when the curd has partly softened into oil, which gives a richer taste.

2177. *Salmon is seldom taken by the angler in the south part of Britain;* but in Scotland, as well as in Ireland and Wales, fishing it by the line is much practised, and affords much amusement.

Subsect. 2.—*The Salmon Trout* (*Salmo Trutta*, Linn.).

2178. This, called also the *sea trout*, appears to connect the salmon and the trout. It, like the salmon, frequents both the sea and rivers, ascending the latter to spawn. It is chiefly found in the rivers of mountainous countries, and is frequent in Wales and the lake district of England. It seldom exceeds a foot in length, but is a very delicious fish.

Subsect. 3.—*The Bull Trout* (*Salmo Eriox*, Linn.).

2179. This fish is not held in such estimation as the salmon or salmon trout, but sometimes attains the weight of fifteen or even twenty pounds. Few are sent to the London market.

Subsect. 4.—*The Common Trout* (*Salmo Fario*, Linn.).

2180. This fish is an inhabitant of clear and cold streams and lakes in most parts of Europe, and is less rich and oily than the salmon, but is esteemed a great delicacy for the table. It is supposed that there are several varieties; the colour of the flesh of some being reddish, of others yellowish, and of some it is white; the first are generally preferred. The female is of a brighter colour, and more beautiful than the male. It swims rapidly, often, like the salmon, leaping to a great height in ascending the rivers. They are in season during the summer months, or from the end of February till August, but are best in May and June, and afford great sport to the angler. They are of more quick growth than any fish except the salmon, but do not live to a great age; the duration of its life is supposed not to exceed eight or ten years. Its general length, when full grown, is about twelve or fifteen inches. When trout are in season, the scales are very bright and silvery; they should be cleaned and gutted when they are to be sent to any place, and closely packed, lying on their backs in a willow basket with dry straw; grass or rushes are apt to heat and spoil the fish. Before being dressed, they are much improved by crimping, and epicures direct that they should be killed by a blow on the head the moment they are taken out of the water. When the trout have arrived at home, lay them on cold stones until wanted; they should be dressed the day they are caught, and never put to soak or soften over the fire in cold water, as is the general practice. If trout are suffered to remain in water after being sufficiently boiled, they will directly become soft, and lose all the firmness given them by crimping. They should be boiled in water with a handful of salt put in. Salt water acquires more heat than fresh, and, consequently, hardens the curdy matter of the fish more. Trout feed well in stews, and will attain the weight of a dozen or fifteen pounds.

Subsect. 5.—*Samlet.*

2181. A fish, called the *parr* or *samlet*, about five inches in length, appears in our rivers in autumn, and has been supposed by some to be a distinct species; but it has been made out by Mr. Shaw that it is nothing more nor less than the fry of the salmon.

Subsect. 6.—*Charr* (*Salmo Alpinus*, Linn.).

2182. This delicious little fish, which is considered as superior to the salmon, inhabits deep lakes in alpine countries, even those which are extremely cold, and covered with ice half the year. Its flesh is rich, extremely red, and full of curd or fat. A few are found in certain lakes in Wales; but the largest and most beautiful are in the Lake of Windermere in Westmoreland: these are nine or ten inches in length. Being considered as a rarity, this fish is often preserved potted. Its figure is rather more slender than that of the trout. There are several varieties; that of Wales is different from the charr of the lakes of Westmoreland.

Subsect. 7.—*The Grayling* (*Salmo Thymallus*, Linn.).

2183. This fish is not met with in the rivers near London, and seldom in the south of England; but, being an alpine fish, delighting in rivers with rocky bottoms, it abounds in the rivers of Derbyshire, Wales, the Severn, Wye, and Trent. In shape it resembles the trout, but it is rather longer and more slender, being generally about sixteen inches in length. It is much esteemed as a table fish for the delicacy of its flesh, which is firm, white, and of a fine flavour. It is considered in the highest season in the depth of winter. When first taken out of the water, it has a very peculiar smell, resembling thyme, said to be occasioned by its feeding upon water thyme. As the trout is a spring and summer fish, the grayling may be considered an autumnal and winter fish. It has been supposed to be migratory, but Sir H. Davy has shown that it cannot bear even brackish water.

Subsect. 8.—*The Gwinead* (*Salmo Lavaretus*, Linn.).

2184. This is said to constitute an intermediate tribe between the trout and the herring; and, like the latter, it dies the instant it is taken out of the water. It has been called the fresh-water herring. Like the charr, it is an inhabitant of lakes in high mountainous regions, and in summer approaches the shores in vast shoals in search of food. It abounds in the lakes of Wales and Westmoreland, and is taken by nets. It is nearly a foot in length, but is considered as an insipid fish. The poorer classes salt them.

SUBSECT. 9.—*The Pike* (*Esox Lucius*, Linn.).

2185. The pike is styled by Walton the "tyrant of the fresh waters," as the salmon is "the king." It is found abundantly in most of the European lakes, particularly in the northern parts; and although it has been disputed whether it is indigenous in England, yet it is the opinion of our best naturalists that there is sufficient proof of its being a native. Its usual colour is a pale olive gray, deepest on the back, and marked on the sides by several yellowish spots or patches; the abdomen white, slightly spotted with black; and its mouth is furnished with a prodigious number of teeth. The size of the English pike is considerable. Instances have been known of their weighing forty pounds, measuring three feet in length; but in Lapland and Russia they attain the size of eight feet. The pike is highly prolific, and their multiplication is immense in the northern parts of Russia and Siberia, where they are taken in the greatest plenty, and constitute an article of commerce, being prepared by salting and drying for exportation.

The voracity of this fish is notorious. It subsists on other fish, but will also devour frogs, rats, serpents, and other reptiles, and even the young of aquatic fowl. It is also related that it will sometimes bite the noses of cattle who come to drink, as well as the hands of persons who put them into the water where it is kept; but stories respecting its voracity have been exaggerated. It is a remarkable, as well as a fortunate, circumstance, that in the summer months, when the fry of other fish are so numerous, the digestive functions of this fish are rather in a torpid state, by which its voracity is diminished. It is very long-lived: Pennant mentions one ninety years old. They are occasionally kept in ponds, but are expensive to maintain, as they require much food, and are destructive to other fish.

The flesh is of a good quality, but it is a dry fish; and when it makes a good dish, it is much indebted to stuffing and sauce. If small, they will do fried; but if large, they are best roasted. The pike of the Medway, which feed chiefly on smelts, are of excellent flavour, and that of Hornsea Weir, in Norfolk, is much esteemed. In the time of Edward I. this fish was scarce in England, and was only introduced at great feasts, its price being higher than that of salmon, and ten times that of turbot.

The terms of *pike* and *jack* refer only to the age of the fish, the latter name being employed where it has not attained more than three pounds in weight, or more than twenty-four inches in length. It is stated by Sir John Sinclair as a fact which ought to be better known, that it is dangerous to swallow the bones of this fish, as they are sharp, and of a texture so peculiarly hard that they will not dissolve in the stomach.

SUBSECT. 10.—*The Carp* (*Cyprinus Carpio*, Linn.).

2186. The carp is found in rivers and ponds; but they appear to prefer slow and stagnant waters. Their usual length in this country is from twelve to eighteen inches, but in warmer climates they often attain the length of two or three feet, and weigh from twenty to thirty pounds. In the Lake of Como they are said even to weigh occasionally 200 lbs. The usual food of the carp consists of worms and aquatic insects; but they feed also on herbs, and, when in course of fattening for the table, bread and milk. It is extremely prolific, and very tenacious of life. As they live long after being out of the water, it is recommended to kill them as soon as they are taken, otherwise they waste.

Carp are easy of digestion, and afford pretty good food, but are greatly indebted to the cook for the estimation in which they are held. They are frequently kept in fish ponds, and live to a great age; some live even a century or more: they may be tamed so as to feed out of the hand.

The sale of carp constitutes a part of the revenue of the nobility and gentry in Prussia, Pomerania, Saxony, and other places in Germany; consequently, in these countries, the cultivation of carp is regarded with particular attention. The southern parts of Europe are most congenial to it; a few breed in the ponds in Scotland; it is supposed to have been first introduced into England in 1514. Its season is the spring, in March and April, and from that till October they are to be had; in winter they are supposed to lie in the mud.

A variety, called the *Grecian carp*, is found in some of the ponds about London, in the vicinity of the Thames, and is also common in several of the counties of England. Their usual size is half a pound; and they are supposed to have been introduced from Germany.

2187. *The gold carp*, or *gold fish* (*Cyprinus auratus*, Linn.), is one of the most beautiful and interesting of all the finny animals, but better known among us for its value as an ornament than for its qualities as food, although they are sufficiently large and numerous in some places, as in the Mauritius, to be served up at table as fresh-water fish. The extreme elegance of their form, the splendour of their scaly covering, the grace and agility of their movements, and the facility with which they can be kept alive in small glass vessels, cause them to be ranked among the most pleasing of our pets. This fish breeds freely in small ponds, and even in tanks, in this country; but particularly so, if by any contrivance the temperature of the water can be kept a few degrees above the ordinary mean.

SUBSECT. 11.—*The Perch* (*Perca Fluviatilis*, Linn.).

2188. This is one of the most common, and, at the same time, one of the best of our fresh-water fishes; its colours are likewise brilliant and striking. It is found in almost all the lakes and rivers in Britain and Ireland, and likewise through the whole of the

temperate parts of Europe. It is remarkably voracious, feeding upon worms, insects, and small fish, and is very prolific; a perch weighing half a pound will contain 280,000 ova. The spawning season is at the end of April or beginning of May; and perch angling commences in February. continuing till the cold weather, if winter comes on. The perch is one of our largest fresh-water fish; one weighing a pound is a good fish, and one of three pounds weight is reckoned very large; but they have been known to reach even eight or nine pounds. They abound most in deep, dark, sluggish rivers, and delight to lie about bridges, mill pools, and in any deep and dark holes in the still parts of water, or the gentle eddies about flood-gates, and similar places. Its flesh is white, firm, of a good flavour, and easy of digestion. It is covered with thick scales, which are troublesome to remove; and is so tenacious of life, that they may be carried sixty miles in straw, and yet survive the journey. They are best crimped the moment they are taken out of the water.

2189. *The Ruffe*, or *Pope* (*Perca cernua*, Linn.), is a small fresh-water fish, closely allied to the perch, and found commonly in all the rivers and canals of England, preferring slow, shaded streams; they abound in the Thames, Isis, and Cam. It is much like the perch in flavour, being firm, delicate, and well-tasted, and is excellent broiled in buttered paper.

SUBSECT. 12.—*The Roach* (*Cyprinus Rutilus*, Linn.).

2190. This fish inhabits deep, still rivers with a sandy bottom, in Europe and the adjacent parts of Asia; and is very numerous in most rivers of England. It seldom exceeds a pound and a half. It spawns in May, and is in season from September till March; it is very fertile, the eggs are greenish, but become red by boiling. The roach is a yellowish, silvery fish of the carp kind, and will breed in ponds, but not so well as in rivers. Some prefer dressing them by scoring across the sides, and broiling them with the scales on. It is rather an insipid fish, and very bony. The finest are caught in the Thames about the middle of May, or early in June, or afterward in October; vast shoals are taken in Loch Lomond with nets. "As sound as a roach" is a proverb; but this is derived from the French name of this fish being *roche*, which also signifies a rock.

SUBSECT. 13.—*The Fresh-water Bream* (*Cyprinus Brama*, Linn.).

2191. The bream is found in shoals in rivers and lakes, particularly when the latter are large, as those of Cumberland. It also occurs in most of the rivers near London, and is found in abundance in the River Mole, and some in the Regent's Canal. It may also be bred in ponds. It feeds upon worms and some vegetables, and much resembles the carp. Its best season is May; some think in September. It is not much esteemed for the table, being insipid and very bony. It sometimes grows to the length of two feet, weighing ten pounds.

SUBSECT. 14.—*The Tench* (*Cyprinus Tinca*, Linn.).

2192. The tench is fine-flavoured, and generally considered as a rich fish in England: it appears to be a native of most parts of the globe, inhabiting chiefly large stagnant waters with a muddy bottom, as well as rivers. Its general length is about twelve or fourteen inches, but it grows sometimes to two or three feet; seldom weighing five pounds. Like the common carp, tench delight in warmth; they are scarce near London, and thrive best in foul and weedy waters. Some extensive tracts of stagnant water in Norfolk abound in tench, from which they are removed to stews, where they are fattened upon a mixture of greaves and meal. They do not thrive northward, and few are found near Edinburgh. From the facility with which they may be bred, and the ease in transporting them, from their tenacity of life, they perhaps deserve more attention than is paid to their cultivation. They spawn in the spring.

SUBSECT. 15.—*The Gudgeon* (*Cyprinus Gobio*, Linn.).

2193. This fish is of the carp genus, and in length about eight or nine inches at the utmost, seldom weighing more than half a pound. It is found in gentle streams and lakes. It is tenacious of life, and remarkably fertile. Gudgeons are in season in the spring, or from March and April to May, and may be had for five or six months; yet in the hot summer they are very indifferent. They are firm, well-flavoured fish, and much esteemed for the table, being little inferior to the smelt. They should be cooked in a frying-pan, in a few hours, or as soon as possible, after they are caught, and without being scaled or opened; they only require wiping with a wet cloth: opening and washing spoils them. They afford much amusement to anglers, fifty dozen a day having been taken. Being a gregarious fish, they may be seen in summer in the bottoms of clear rivers by hundreds together, and they will live and breed in ponds. They are very fine and numerous in the Rivers Thames, Lea, Mersy, Colne, Kennet, Avon, and also in the New River. The London fishmongers keep them alive for several weeks in leaden or stone tanks, constantly supplied with fresh water. In Bath, they are exposed for sale alive in tubs, and are thus to be had in perfection: they are considered as very easy of digestion, and therefore fit for invalids. Of the genus Cyprinus, some are migratory,

inhabiting both the fresh and salt waters, while others remain in fresh water throughout the year.

SUBSECT. 16.—*The Barbel* (*Cyprinus Barbus*, Linn.).

2194. *This is a common fresh-water fish*, belonging to the carp family, which derives the appellation of *barbus*, bearded, from the upper jaw advancing far below the lower, and in having four appendant barbs at its mouth. It is found during summer in the rapid currents, and at the stony bottoms of tide rivers, retiring at the approach of winter to the more still and deeper places. Barbels sometimes grow to the length of two or three feet. They are ground, or bottom fishes, lurking among the stones and under-banks, and are usually found when moderate floods bring down small animals, as snails, leeches, &c., as food. There is an ancient idea that the flesh of the barbel is unwholesome, which is, perhaps, a prejudice; but it is not of a very good flavour, and is little esteemed: no doubt when the fish are out of season they are, like most other fish in the same condition, not wholesome. They are seldom eaten except by the lowest of the Jews. They are understood to be very voracious and indiscriminate in their feeding; and it is said that the roe is sometimes violently cathartic. The Thames, from Putney upward, produces barbels of large size and in great quantities; also the Lea in Essex; but they are chiefly valued as affording sport to the angler.

SUBSECT. 17.—*The Dace* (*Cyprinus Leuciscus*, Linn.).

2195. This fish is of the carp genus, and has a bright, silvery colour. It is considered to be light, nutritious food, though full of bones, and is caught in most rivers and streams, but does not thrive in ponds or still waters. These fish never attain a great size, seldom weighing a pound. They are cooked in the same manner as roach, which they much resemble, and to which they are rather superior, though not so plentiful. They are gregarious, swimming in shoals, and spawning in June. The *Graining* is a variety of the dace, rather more slender.

SUBSECT. 18.—*The Rudd* (*Cyprinus Erythropthalmus*, Linn.).

2196. This fish is very common in the Thames and other rivers of England, as well as the rivers of the Continent. It may be often purchased in Hungerford fish-market, but is sometimes mistaken for roach, to which it is inferior, the flesh being soft and full of bones. It seldom attains two pounds' weight. The roach, bream, and rudd are much alike.

SUBSECT. 19.—*The Chub* (*Cyprinus Cephalus*, Linn.).

2197. This is a river fish, of the carp genus, somewhat resembling the tench. They are very common in England and Scotland, and delight in deep holes in ponds and canals, but chiefly in clear and rapid rivers. When full-grown, they are from twelve to fifteen inches long, and in weight four or five pounds. When quite in season, and only two or three pounds, they greatly resemble carp, and are usually dressed in the same manner; but they are not very palatable, being watery, tasteless, and bony, and are apt to acquire a yellow colour in boiling; they are therefore held in little esteem. The best manner of dressing this fish is to stuff and roast, or broil it with the scales on, when it is pretty good. It affords good amusement to anglers on the Thames.

SUBSECT. 20.—*Bull's Head, or Miller's Thumb.*

2198. This singularly-formed fish is of the gudgeon kind, with the scales extremely small, the head large and flat, and the mouth wide. It seldom exceeds five or six inches in length, and is met with in almost all shallow rivers, abounding in the New River. The fish is well tasted, and turns red or salmon colour on boiling.

SUBSECT. 21.—*Loach* (*Gobitis Barbatula*).

2199. The loach is a very small fish, generally about three inches long, having a round body with six wattles, or barbs, at its mouth. It is not very common, but is found in small brooks and rivulets. It is chiefly used as bait for fishing large eels and perch; but is delicious fried in batter, or with eggs and crumbs of bread.

SUBSECT. 22.—*The Bleak* (*Cyprinus Alburnus*, Linn.).

2200. This is of the carp genus, and is abundant in most of our rivers, particularly the Thames and Lea. It is in little esteem for the table, being chiefly taken for the sake of its beautiful, silvery scales, which are made use of in the manufacture of artificial pearl; but it is also occasionally substituted for the anchovy, though it has not the same flavour. Its length is about five or six inches, slender in shape, colour bright silvery, with the back olive-green. Its tail is forked, and, from its continual motion, it has been called the river swallow; by some the fresh-water sprat.

2201. *Stickleback.*—This very small fish, which is generally under two inches in length, is a frequent inhabitant of rivers, ponds, and marshes, as well as the sea; it receives its name from the sharp spines on its back. It is sometimes very troublesome in fishponds when it gets into them, being extremely pugnacious, and attacking the larger fish. In the fens of Lincolnshire they are in such quantities as to be taken out in cart loads, and are employed to manure the fields.

SUBSECT. 23.—*The common Eel* (*Muræna Anguilla*, Linn.).

2202. This fish is migratory, and inhabits both salt and fresh water; it is, accordingly,

taken in rivers, lakes, and ponds, as also in the sea. In its form it makes a near approach to the reptiles, having no fins except the pectoral. In the water, no fish is more vivacious, and, as it clings to life very tenaciously when out of the water, it may be kept alive for several days in wet sand. It is, however, very sensible of cold, and, to avoid this, it buries itself under the mud in the winter. There are no eels in the arctic regions, and none in Siberia.

In some parts of Europe the eel fishery is of surprising magnitude. Dr. Black says that in some places near the mouth of the Baltic so great a quantity is taken that they are salted for exportation, and conveyed by wagons into Saxony, Silesia, &c. Two thousand have been taken in Jutland by a single sweep of the net, and in the River Garonne sixty thousand have been caught in a day by a single net. Ponds are sometimes appropriated in England to the raising of eels; and large quantities are caught in the Thames and other British rivers.

2203. *The consumption of eels in our large cities is considerable.* The London market is principally supplied from Holland, by Dutch fishermen. Mr. Yarrell observes, "There are two companies in Holland, having five vessels each; their vessels are built with a capacious well, in which large quantities of eels are preserved alive till wanted." One or more of these vessels may be constantly seen lying off Billingsgate; the others go to Holland for fresh supplies, each bringing a cargo of 15,000 to 20,000 pounds weight of live eels, for which the Dutch merchant pays a duty of 13*l.* per cargo for his permission to sell.

2204. *As an article of food*, eels are extremely rich and nutritious; but on account of the large quantity of oil which they contain, they are apt to occasion derangements of the digestive function, and require as a corrective to be eaten with vinegar, or some other condiment. Their use in pies is well known. They are also eaten fried, stewed, and plain boiled.

2205. *There are several varieties of the fresh-water eel.* The true *silver eel*, so called from the bright colour of its belly, is caught in the Thames, and is superior to most others. Those taken in running water are preferable to what are taken in ponds; the latter often have a rank, muddy flavour. The *Dutch eels* sold at Billingsgate are of this kind. The *sand eel* is a small fish of a delicate flavour, found buried six or eight inches in the sand left dry at low water.

2206. The body of the eel is covered with a slimy mucous substance, which makes them very slippery, and difficult to hold in the hand, whence the well-known saying. It is a common notion that eels have no scales; but that is an error; they have scales, which are easily seen when they are wiped and dried, particularly if a magnifying glass be used.

2207. *The cruelty of skinning eels alive may be avoided* by first cutting off the head, which destroys the sensibility. The writhing motions which they then exhibit in being skinned are thought not to be owing to their being sensible of pain, but merely to what is termed irritability, which does not cease immediately on the death of the animal. Eels have this peculiar property, that they are never out of season, though they are best in the summer months.

2208. *It is a curious fact in natural history that the manner in which eels breed is yet a problem not completely solved.* It has been generally said that they are viviparous; but Sir H. Davy observes, in his "Salmonia," "No facts are produced in proof of the assertion. It is certain," he says, "that shoals of very small eels are seen in the spring, making their way from the sea to the rivers; and that in the autumn great numbers are known to descend from the rivers to the sea. They even ascend the rivers over wet mossy rocks. In fresh water they fatten and grow large." The opinion of this acute observer was, that eels are oviparous, and deposite their ova in parts of the sea where they may remain warm in the winter, and that the young ascend rivers in search of food.

2209. *Ells were considered* by the ancient Romans as one of the most luxurious articles of the table. They were kept alive in reservoirs, and occasionally tamed to such a degree as to come at the signal of their master, in order to receive their food.

2210. *The Eel Pout*, or *Burbot*, is a fish much resembling the eel, and is found buried among loose sands, weeds, &c., in the Rivers Severn, Trent, and Mersey. They are sweet and nutritious: in length, from twelve to twenty inches.

SUBSECT. 24.—*The Minnow* (*Cyprinus Forinus*, Linn.).

2211. This is a very small fish, inhabiting rivers, and brooks, and canals, and chiefly known as affording amusement to juvenile anglers. They are of good flavour, and when a sufficient number can be procured by a casting net, make an excellent fry, somewhat like white bait, but rather luscious and cloying. In Walton's time, a dish called minnow tansies was made from them, now out of use. They were gutted, well washed in salt and water, and after their heads and tails were cut off they were put with yolks of eggs, well beat with cowslips and primrose flowers, and a little tansy shred small, and fried in butter; the sauce being butter, vinegar, or verjuice and sugar.

SECT. IV.—SHELL-FISH.

2212. Under this popular term we comprehend the two divisions of *crustaceous animals*, as lobsters, crabs, shrimps, &c., which have shelly coverings with feet; and *molluscous*

animals, or molluscæ, as oysters, cockles, periwinkles, &c. These are now separated by naturalists from the class of fishes; they are in immense variety; many are used as food, but some of the naked molluscæ, or those without shells, are poisonous. Arranged under the genus cancer there is an immense number of crustacea in different parts of the world, but only a few species are found on the British shores.

SUBSECT. 1—*Lobster* (*Cancer Gammarus*, Linn.).

2213. *The common lobster frequents* all the northern seas of Europe. They are found on the rocky coasts of England and Scotland, but chiefly where there is a depth of water. Vast quantities are brought to London from the northern parts of Scotland, and particularly from the Orkney Islands, in smacks that have wells for keeping them alive. They are still more abundant on the coast of Norway, from which the metropolis is well supplied at most seasons of the year. A recent traveller in Norway saw an export of 46,000 lobsters shipped for London within three months from one place; and a regular "English lobster company" has agents actively employed all along the coast. Occasionally, though rarely, lobsters are taken by the hand, or rather by a hook, from under hollow stones, at low water, but by far the greatest quantity are caught in a kind of trap formed of twigs and baited with garbage; these are fastened by a cord and sunk into the sea, and their place marked by a buoy.

Lobsters are highly prolific; 12,400 ova or eggs have been counted under the tail of one female, besides that which remained in the body unprotruded. The eggs are deposited in the sand, where they are hatched.

They change their shells annually. Previously to putting off their old one, they appear sickly, languid, and restless; and they acquire a new coat in a few days after casting off the former one. During the time that they are thus defenceless they seek very retired places, for fear of being attacked and devoured by such of their brethren as are not in that weak condition. The new shell is membranous at first, but hardens by degrees, and they grow in size while the shell is in this soft state. The circumstance of lobsters throwing off their great claws voluntarily is very surprising, but sufficiently authenticated. If taken or entangled by the great claw, they will sometimes part with it by a sudden jerk, and thus effect their escape. Pennant says that when irritated, as when it thunders, or when great guns are fired, they will lose their claws. And scarcely less extraordinary is the reproduction of these members, which grow again in the course of a few weeks after the mischance has happened; but the new claws are not quite so large as the former ones. In the water they can run nimbly upon their legs or small claws, and, if alarmed, can spring tail foremost to the surprising distance of thirty feet, and as swift as a bird can fly. They are extremely voracious, feeding upon any kind of dead fish, and sometimes on sea-weed.

2214. *Lobsters are certainly nutritive, but not so much so as is commonly supposed*; they are not very easily digestible, and therefore require condiments, of which the most proper are those usually made use of, vinegar and pepper. On certain constitutions they have sometimes pernicious effects, and are known to have occasioned eruptions on the skin, and other distressing symptoms of derangement. Great care should be taken that they be in good condition, and absolutely fresh. When stale they are undoubtedly unwholesome in a very considerable degree. The fishmongers in London generally underboil them, with a view to their keeping, in which case they are extremely indigestible. According to Dr. Kitchener, they come into season about April, and continue plentiful till the oyster season returns in the autumn.

2215. *Lobsters brought alive from the northern extremity of the island in smacks with wells* for the purpose are often much wasted on their journey; their weight, therefore, is one proof of their goodness: but to ensure their being fresh, it is best always to buy them alive, and to boil them at home.

2216. *The ova* or *eggs*, *called by the cook berries*, and sometimes the *coral*, appear under the tail of the hen or female lobster only, and are black when raw, becoming in succession nearly as large as elder-berries before they are all deposited; the lobster continues depositing them as long as any remain in the body; when boiled, they are of a beautiful red colour.

It is a common mistake to suppose that a berried lobster is always in perfection for the table. When the berries are large and brownish, the lobster will be found exhausted, watery, and poor. The male lobsters are preferred for eating, particularly during the winter: it is distinguished from the female, not only by its want of the eggs under the tail, but by a narrower back part to the tail, with a strong spine upon the centre of each of the transverse processes underneath it, which supports its four middle plates; the two uppermost fins within his tail being stiff and hard, while those of the female are soft, and her tail broader. The female is best for sauce, on account of her eggs. The bag in the body of the lobster, called the "old lady in her arm-chair," containing the bony teeth, is the stomach, and is not fit to be eaten.

In choosing lobsters that are boiled, select those that are of a middling size, and heaviest for their bulk: to know if they are fresh, try if the tail has a springiness and will flap back again when raised up.

2217. *The common sea crawfish* (*Cancer palinurus*) is similar in its general properties to the lobster, but is less esteemed.

SUBSECT. 2.—*The Crab* (*Cancer Pagurus*, Linn.).

2218. *The crab inhabits most of the rocky shores* of England, and is taken in the same way as the lobster. It is in the highest perfection for the table about Christmas. The same observations which were made with respect to the nutritive and other qualities of the lobster apply to this crustaceous animal. Besides the cancer pagurus, the crab, which grows to a large size, and which is the only one brought to the table, is called, in Scotland, a *parten*; there is another much smaller, and without hairs (*Cancer mænces*), more frequent about the shore; but this is a very poor, watery animal, of a greenish colour, and eaten only by the more indigent classes of people.

Crabs are found under large stones at low water, and are taken with a long stick having a hook at the end. But, on a larger scale, they are caught on the coasts of England and Scotland, in water from three to five fathoms deep, by sinking wicker traps containing bait, consisting of heads and entrails of fish. Many are brought from Norway. The male crab has the claws larger than the female, and is therefore of greater value. The female has the apron large, broad, and easily opened: that of the male is much smaller and narrower.

The best crabs have a considerable roughness on their claws; those with smooth shells are not so good. The crab is peculiarly tenacious of life, and is capable of exerting a considerable degree of muscular power after it has been removed two days from its natural element. It is often alive and fit for the table when, to all appearance, it seems to be dead. If any spark of life remain, it will be exhibited by the creature's exertions to keep the apron closed with its claws.

Crabs, as well as lobsters, are apt to throw off their claws on the stimulus of any sudden fright or pain, and therefore it is the practice, though a cruel one, in boiling them, to put them into cold water, by which they die gradually as the heat increases.

Crabs are in season all the year, except the months of May, June, and July; and a few may be had good at any time of the year.

Our English crabs are entirely marine; but in other countries there are also freshwater species; and in tropical climates land crabs are plentiful. *The land crab of the West Indies* (*Cancer ruricola*) lives in the mountains, and inhabits clifts in the rocks, hollow stumps of trees, and holes which they dig in the ground. Once a year they march down in a body to the sea side for the purpose of depositing their spawn in the sea, and, having accomplished this object, they bury themselves in holes in the ground, and cast their shells. They are often found in this condition, and in a fattened state, and are then highly prized as a wholesome and delicious food. There are two varieties of the land crab in Jamaica, one white, and the other black. The black crab is found abundantly in the eastern and northern marshes of the island during particular periods of the year; it is of the blackness of the lobster, and of a very light and handsome shape, as compared with any other species; it is very active upon its legs, and runs fast. The white land crab is very abundant in the low districts of the south side of the island: it is not so active in its movements as the black.

SUBSECT. 3.—*The Shrimp* (*Cancer Crangon*, Linn.).

2219. This lively little animal inhabits most sandy shores in Europe. It is too well known to the cook to require any description. As they are sold in London, they have almost always a great quantity of salt to make them keep, which overpowers their delicate and fine flavour. The Isle of Wight is famous for shrimps, where they are potted; but those prepared for London are generally too much salted.

2220. *The Prawn* (*Cancer squilla*, Linn.) is very analagous to the shrimp, but larger, finer, and less common.

SUBSECT. 4.—*The Oyster*.

2221. Oysters are almost universally distributed near the shores in all latitudes, and abound on the coasts of Britain and France, where they form a very important article of food. There are a great many species of oysters in other countries, but all those on our shores that go by the name of the common oyster belong to one species, the *Ostrea edulis* of Linnæus.

The nervous system of the animal is limited to the faculties of sense and touch, no especial organs for seeing having been yet discovered. Each oyster is perfect of itself, that is, capable individually of reproducing its kind.

2222. *In the breeding season*, which is in May, June, and July, the ovary is filled with a milky fluid, which contains a great number of ova, or eggs, of a whitish colour. Oysters are extremely prolific, and the young ones in the ova may be seen by the microscope floating in a viscid liquid. In May or June the young have reached their full size, leave the ovaries, and are then called by the fishermen *spawn* or *spat*.

Oysters adhere not only to rocks, but to any solid bodies that their spawn may light upon when cast, as small stones, wood, sea-plants, old oysters, or other shells, and a

thousand things which are found at times with oysters growing in them. The spawn appears at first as a viscid matter, and is in great abundance; but much of it is destroyed by fish and crabs. The material at the bottom of the sea, to which the spawn adheres, is called by the fishermen *cultch*; and they are careful not to destroy it. Places that abound with sea-weeds or mud are not favourable to the propagation of oysters. It is conjectured that in twenty-four hours the spat begins to have a shell.

If an oyster happens to be cast on shore, it soon dies; but if deposited in places which are flooded at high water, they will keep their shells closed when it ebbs, and thus preserve their existence. When oysters are recently taken up from places that are never left dry by the sea, they open their shell, lose their water, and die in a few days; but kept in reservoirs in which they are left occasionally by the sea, exposed to the rays of the sun, or to severe cold, or when they are disturbed in their beds, they acquire the habit of keeping the shell close when they are uncovered with water, and exist without injury for a long time.

2223. *Oysters, being fixed to the rock, or some solid body, are usually supposed to have no power whatever of locomotion; nevertheless, it is said that they do possess this in a small degree*, by means of an organ called the foot, which is composed of various layers of fibres, that by their contraction bestow on it the power of motion. A very strong muscle, which is always cut across when the oyster is opened with the knife, named the adductor muscle, is attached to the interior opposite sides of the valves or shells; when this muscle is in a state of contraction, the shells are kept closed, and when the muscle relaxes, the shells open. When the animal dies, this muscle, of course, loses its power, and the shell gapes.

The oyster has many enemies which prey upon it, notwithstanding its shelly defence: the asteria, or sea star, clasps its arms or rays round the shell, and forces it open: crabs and lobsters are also destructive to a bed of oysters.

2224. *Oyster shells are composed* of carbonate of lime, cemented by animal matter of an albuminous nature: in some places they are burned for lime. A century ago they were employed medicinally calcined, though they are now considered as no way different from any other carbonate of lime.

2225. *The oyster fishery* is so important in Britain that it is regulated by the Admiralty Court. In the month of May, the fishermen have liberty to take every kind of oyster, whatever be their size. When they have collected them, they gently raise with a knife the small brood from the cultch, and then they throw the latter in again, to preserve the ground for the future, unless they have so much spat that they cannot be severed from the cultch, in which case they are permitted to take the stone or shells which the spat is upon, one shell having often twenty spats. The spat is then carried to creeks of the sea, where the water is still, and thrown there in order that they may grow large and fat, and that they may be easily obtained when wanted. In eighteen months they are grown sufficiently to be brought to market, but are not in perfection till about two or three years. The oysters are sick after they have cast their spawn in May, and they are then unfit for food; in June and July they begin to mend, and in the beginning of August they are recovered: on the fourth of that month they are permitted to be brought to the London market. All the winter they continue to be taken, and the oyster season terminates on the 12th of May.

2226. *The oysters fattened in artificial beds* are young, and generally reckoned the most delicate; but some persons prefer those that grow upon their native rocks, as having a higher flavour. Although oysters are among the natural productions of our coasts, yet this source is not entirely depended upon; but young oysters, of a size not exceeding a penny-piece, are obtained from various parts, and carefully planted in the artificial beds. The method of forming these artificial oyster-beds was known to the ancient Romans, who were exceedingly fond of this fish. The beds are mentioned by Pliny as the invention of one Sergius Orata. It is not a little remarkable that the finest oysters eaten in ancient Rome were fed in the channel which then separated the Isle of Thanet from England, and which has since then been filled up, and is now converted into meadows. It is extremely probable that the custom of forming oyster beds has been continued on our coasts ever since. Oysters have been reared in beds, ever since the times of the Romans, in the Lake Facino, on the coast of Baia near Naples, as described by Count Lasteyrie; this lake communicates with the sea by a narrow passage; along the margin of the lake are placed circles of reeds, with their summits above the water; the spawn of the oyster attaches itself to these reeds, and grows there till of an edible size: the reeds are pulled up and examined, and the full-grown oysters are removed, and put into the reserve till wanted: the small-sized and spawn are, with the reeds, put back again. It requires two years before the oysters come to their full size.

2227. *The means adopted for fattening oysters*, when transplanted, is one of the chief causes of their excellence. Nearly all the oysters brought to London have been so improved. The breeding-places are generally held on leases by a copartnery, consisting of a considerable number of individuals; and disputes often occur between the lessees of an oyster-bed and the fishermen. In some places, the latter contend that unfair

modes of dredging are practised; and also that from those parts of the coast where no peculiar rights exist, the brood is carried away and planted in the beds, which are protected by law, thus making the weaker party contribute to the success of those who are already in possession of many important advantages.

It is certain, however, that the protected beds are a much more productive source of profit, both to the dredgers and to the public, than those which, from various causes, are left at the mercy of parties who are not locally interested in their preservation. In England, the oysters from the beds at Milton, in Kent, forty miles from London, are in high repute, as the whitest and most delicate, and are consumed in every part of England under the title of "native oysters." The native oysters are properly those that are born and bred in this country; and the Milton natives are mostly spat in the Burnham and Mersey Rivers, and placed in the Milton beds: they do not come into their finest condition till near four years old. The beds at Colchester, Pyfleet, Milford, Maldon, Feversham, Queensborough, Rochester, and those in the Swale and Medway, are also highly esteemed, and help to supply the London market. The common or Colchester oysters come in the 5th of August; but the native Miltons do not come in till the beginning of October, and are in greatest perfection near Christmas. There are also beds in Jersey and on the coast of Wales, which produce large quantities of oysters, some of which are brought to London.

On the Scotch coast oysters are less numerous than on the English, and they are not so frequently reared in beds; but the beds in the Firth of Forth and in Musselborough Bay, taken near the salt-pens, yield oysters of good flavour and of a large size. The Carlingford oyster, on the coast of the county of Louth in Ireland, are said to be of very superior flavour. Oysters from Brittany have been long famous, particularly those from Caucalle, near St. Malo; but those brought from Mercunes in Saintonge are in the highest estimation with the French. The green oysters eaten in Paris are brought from Dieppe. In tropical regions the common oyster is found attached to trees that grow on the edge of the sea, as the mangrove; and though this has been often thought fabulous, it is perfectly true. Many of the branches of these trees grow under water, and are covered with oysters. Instead of taking off the oysters, the branches are sometimes cut off with the fish upon them, carried home in baskets, and placed upon the table in that state.

2228. *Oysters are now most generally eaten raw, and in this state they are every way preferable.* When cooked, they are deprived of their salt water, which promotes their digestion, and they likewise lose much of their nutritive mucilaginous matter, their albumen becoming hard. When good, they are allowed to be, in general, highly nutritious; and with most persons they constitute an extremely light food; but with weak stomachs they are cold, and require the addition of some stimulant; pepper is the best.

2229. Oysters which have been fattened in artificial beds sometimes acquire a green tinge; and it has been supposed that this colour is occasioned by their having grown upon rocks impregnated with copper, and that such oysters, consequently, have a poisonous quality. As this is a popular error, it is proper to set the matter right. The green tinge is not owing in any instance to copper, but is derived, according to some, from the oysters feeding upon the minute plants, called confervæ, that grow abundantly in those places where the water is shallow and the sun has great power; the green colour is thought to be owing to a peculiar state of the bile. Oysters may be made green in such places in three or four days. When persons have been made ill from eating such oysters, they would, in all probability, have experienced the same effects from eating an equal quantity of any others. There are no rocks whatever containing copper in the places where our oysters are taken, nor can the slightest trace of copper be detected in them by chemical tests. The popular notion that oysters possess aphrodisiac properties appears to have no foundation.

2230. *Like all fish, they are out of season at spawning time;* and hence the origin of the old saying that "an oyster is never good except when there is an R in the month;" but this supposes that they are not to be eaten in August, and some are of opinion that they are not thoroughly fit till the beginning of September. During the period from the 12th of May to the 4th of August they are prohibited being taken or sold, in consequence of their being considered as unwholesome, the clerk of Billingsgate being empowered to seize and destroy all that are there offered for sale within the jurisdiction of the lord mayor. The magistrates of Rochester and Milton, however, not being empowered to proceed against the offenders, an illicit trade is carried on there.

2231. *During the season, the consumption of oysters* in London is immense, and no article of diet is more generally used by every class. The number of dealers is proportionably large, the poorest streets not being without one or two, generally supplied, at least, with the large but less delicately flavoured oyster.

They are kept alive for consumption for several days, or a week, in tubs containing water in which a quantity of salt is dissolved, with a little oatmeal added, for the oysters to feed upon, and thus be in condition. They are sent into the country, packed close in small barrels at the beds. Frequently what is sold as barrelled oysters are merely the

smallest natives, selected from the stock and put into the tub when ordered; and, instead of being of superior quality, they are sometimes very inferior. At Billingsgate they are sold out of boats which lie alongside the market, in quantities not under one peck; and at the opening of the season the line of dealers extends all along Thames-street and over London Bridge. Many are exported to Holland, Germany, and other parts of the Continent.

Subsect. 5.—*The Scallop* (*Ostrea Maxima*, Linn.).

2232. The shell of this fish is well known as that which was formerly worn on the hat or coat by the pilgrims, as a mark that they had crossed the sea for the purpose of paying their devotions in the Holy Land; and in commemoration of this it is still preserved in the arms of many families. It is a *pecten* in the system of Lamarck, and is a very elegant shell, of a great variety of colours, acquiring the size of five or six inches across. It lies at the bottom of deep water, in beds, from which they are dredged up. The fish is very palatable, though of a peculiar flavour, and seldom eaten but in the fishing towns. It is boiled, roasted, or baked, or pickled in vinegar.

Subsect. 6.—*The Muscle* (*Mytilus Edulis*, Linn.).

2233. *The muscle is found* adhering to rocks by a strong silky beard, frequently in such quantities as completely to cover them. Since many persons who have eaten muscles have suffered severely, these fish are generally supposed to be occasionally poisonous. The cause of this does not appear to have been sufficiently ascertained. Some pretend to take out the part which they suppose to be deleterious, namely, a dark substance, and, in fact, the heart, which is perfectly harmless; others speak of the beard as indigestible. Lately, M. Bremnil is said to have discovered that the poisonous property of muscles depends upon the presence of a minute star-fish which enters into the shell in summer, but is never found in it in winter. He collected some of these star-fish, and gave them to dogs, upon whom the same symptoms were produced that appear when poisonous muscles are eaten. There are likewise fresh-water muscles, but they are never eaten with us.

Subsect. 7.—*The Cockle* (*Cardium Edule*, Linn.).

2234. The common cockle is a bivalved shell-fish found on all the sandy shores of Europe. Cockles bury themselves in the sand, out of which they are dug. They have a peculiar and agreeable flavour, and form an extremely wholesome food. They vary considerably in size on different coasts, and are very large on some of the Scottish shores. They are eaten boiled, plain, or fried, and are frequently used for sauce instead of oysters. Some have described them as of difficult digestion; but this does not appear to be the fact, from their universal use and general good character.

Subsect. 8.—*The Razor Fish* (*Solen Siliqua*, Linn.).

2235. This is a bivalved shell-fish, so called from the shells having nearly the form of the handle of a razor; it is only found on some particular coasts, and burrows in the sand. It is about six or seven inches long, and about one inch broad, the hinge being on the middle of the side. When the two shells are closed, they resemble a tube open at both ends. Part of the fish is of a cylindrical form, white and firm. They are eaten boiled or fried, and are very delicate and wholesome, although, perhaps, not very digestible.

Subsect. 9.—*The Periwinkle and Whelk.*

2236. These are well known univalved molluscæ, of little importance as general food, though eaten by the poorer classes, and sufficiently wholesome.

Subsect. 10.—*Helix Pomatia.*

2237. *A large species of land snail having a shell, called Helix pomatia*, is regularly bred and kept in gardens on the Continent for the table. In Germany, particularly in Vienna, sacks of these molluscæ are brought to the markets and sold; they are there considered as great delicacies. The enclosure in which they are kept is surrounded by boards, having the upper edge covered with small iron spikes, over which the snails never attempt to pass. They are fed upon cabbage leaves. This article of food was highly prized among the ancient inhabitants of Italy. The Romans bred them in prodigious numbers, fattening them in places called *cochlearia*, a particular description of which is given by Varro; and Pliny informs us that the method was invented by Fulvius Hirpinus, who lived a little before the time of Cæsar. This luxury grew to such a height that it was restrained by a special law. The Helix pomatia, or "esculent snail," was first introduced into England from Italy by a branch of the Howard family, one of the daughters of which, when labouring under consumption, having been recommended to eat soup made of it. Its medicinal virtues are, however, disregarded by physicians. These snails are not common in our fields, but are found at Boxhill, and in the vicinity of Dorking in Surrey. They are never brought to table with us.

Sect. V.—reptiles.

2238. Of reptiles, though some are among the luxuries of the table, yet the greater number are of little value for this purpose; and many are so disgusting in their appearance as to excite a strong prejudice against them; but none of them are known to be of a poisonous, or even unwholesome nature. Various species of *turtle* are well known. Of the lizards, the *dracæna* and *iguana* form excellent food; and the *frog* supplies a favourite dish to our continental neighbours. The flesh of reptiles in general is delicate: the largest muscles are white, and contain a great deal of gelatinous substance: even serpents and snakes of all kinds, whether poisonous or not, are used as food by various nations. The poison of the serpent lies only in some receptacles attached to the fangs in the mouth; if the head be cut off, the body is innocent food. The *boa-constrictor* is considered as a great delicacy: the *rattlesnake* is broiled like eels by the North American Indians. *Viper broth* is known among us, and was formerly recommended as a restorative, although perhaps it is not superior in this respect to what is made from eels.

2239. *Turtle.*—Of the genus *testudo*, some inhabit the sea, and are called turtle; others are named tortoises, and live on land, or in fresh water.

There are several species of turtle used as food; but the best and most celebrated is called the *green turtle* (*Testudo Myas*, Linn.) from the colour of its fat. This turtle, so much prized as delicious food, is a very gentle and harmless animal, and sometimes grows to a great size, weighing from fifty pounds to five or six hundred weight, and measuring five or six feet in length. They abound in the seas of hot climates, particularly along the coasts of Cochin China and the islands of the East and West Indies, and frequently ascend the mouths of rivers. At the Isle of Ascension fifty have been taken in a week. Turtles are only calculated for swimming, the feet being so formed as to resemble a kind of fins or paddles, and they can move on land only with difficulty; nevertheless, they contrive to come on shore, and scratch holes in the sand to deposite their eggs, which they leave, after covering them up, to be hatched by the sun; in about a month the young ones come out and crawl to the water. The eggs are numerous, often amounting to above 100; and the female lays three times in a year: they are generally about the size of a small hen's egg, but sometimes much larger; they are quite round, consisting only of a yolk enclosed in a soft skin like parchment, are very delicious, and are highly esteemed. One of the usual modes of *taking* the turtle is by turning them on their back when they come on shore, from which position they cannot recover themselves without great difficulty. They are likewise caught while lying asleep on the surface of the water, and sometimes they are struck with the harpoon.

Turtle comes to us from the West Indies, some of the ships being provided with proper accommodations to permit them being brought alive and in tolerable health; but frequently they become emaciated during the long voyages, and then are very inferior for soup. There are various modes of cooking this excellent and nutritious food: one of the most usual methods in the West Indies, and perhaps the most wholesome, is to dress the flesh by boiling or frying like a beefsteak. It is also stewed, and made into the well-known turtle-soup, for which we refer to Book XIII., "Recipes in Cookery." What is called the green fat of the turtle is, in fact, not fat, but a gelatinous substance like the skin of a calf's head, or the tendons of the heel: that which forms part of the upper shield of the animal is called *callipash* by the cooks; and what belongs to the lower shield is the *callipee.* These are considered as the *bonne bouche* of the turtle. The flesh of the turtle is seldom dressed in the London taverns in any other way than in soup; occasionally as a steak. Turtle soup, as it is usually prepared here, is apt to disagree with dyspeptics.

Turtle is often a valuable addition to the live stock at sea; and the flesh may be salted and preserved a long time; in this state it is much used in the West Indies and America. Like other oviparous animals, turtles are best in season when beginning to lay their eggs; those which are full of eggs are reckoned the finest; after this, they are out of season. The introduction of this animal into England as an article of luxury is of no very distant date, and can perhaps scarcely be traced farther back than about 70 or 80 years.

2240. *The loggerhead turtle* (*Testudo Caretta*, Linn.) is often larger than the green turtle, and its shell is beautifully coloured, but too thin for manufacture. It is a strong and fierce animal, and even dangerous: it is found in the Mediterranean, but its flesh is coarse and rank.

2241. *The elegant substance known by the name of tortoise-shell* is made from the shell of a variety of turtle called the *hawksbill*, or *imbricated turtle*, which is a native of the Asiatic seas, but found, though much more rarely, in the Atlantic, and even in the Mediterranean. Its general length is about three feet, and the shell is formed in scales that lap over each other like the tiles of a house. The flesh is said to produce fever and dysentery, but the eggs are wholesome. It is a ferocious creature, and defends itself with vigour.

2242. *Tortoises* are of two kinds: the land and fresh-water tortoise. The land species

is distinguished by club-shaped feet, and toes furnished with claws, and has the shell very convex. The fresh-water species have their feet more or less webbed.

2243. *The common land tortoise* (*Testudo Græca*, Linn.) receives its name from abounding in Greece and the countries bordering on the Mediterranean. It is covered by an extremely strong shell, about seven inches in length, and weighs about three pounds. It is a slow, stupid-looking animal, lives upon milky plants, as lettuces, dandelions, &c., delights in warmth, but avoids the heat of the sun in summer, and is equally afraid of rain. In the winter he burrows into the ground, where he remains torpid for some months. Its flesh is eaten by the inhabitants of those countries where it abounds, and likewise its eggs, which it lays in holes in the earth, where they are hatched by the sunbeams. It is well attested that this animal lives to a most extraordinary age, several examples being adduced of its having considerably exceeded the period of a century. One of the most remarkable instances is that of a tortoise introduced into the bishop's garden at Lambeth, in the year 1633, which continued to live there till 1753, when it was supposed to have perished rather from accidental neglect on the part of the gardener than from the mere effect of old age. Its shell is preserved in the library of the palace at Lambeth. The tortoise can refrain from eating as well as breathing for a great part of the year; and, from some experiments made upon it, appears to be tenacious of life in a most extraordinary degree, living and walking about for six months even after being deprived of its brains, and the body lived for twenty-three days without the head.—*Shaw's Lectures.*

The land tortoise occurs in great numbers in various parts of Hungary, more particularly about Fuzes-Gyarmath, and the marshes of the River Theiss; and being esteemed a delicacy for the table, is caught and kept in preserves. The preserve of Keszthely encloses about an acre of land, intersected by trenches and ponds, in which the animals feed and enjoy themselves.

2244. *The mud tortoise* (*Testudo lutaria*, Linn.) is rather less than the last, being about seven inches long, and, though rather an aquatic animal, lays its eggs on the ground. It is common in many parts of Europe and Asia, particularly in France, where it is used as food. It moves quicker than the land tortoise; feeds upon vegetables, milk, worms, or offal, and is frequently kept in gardens to clear them of snails. It is destructive to the fish if it gets into a fish-pond. The flesh is considered as restorative, and useful in warm climates, where in summer the cattle are thin from the irritation of insects, and the poultry rank from the quantity of worms they pick up.

2245. *The river or fresh-water tortoises* are more rare: one of the most remarkable is the *Testudo ferox*, or fierce tortoise, a native of many parts of North America; its head is small, and its neck very long, which it withdraws within its shell. It is an animal of swift motion, and will spring forward with great fury to attack its assailant: the usual length from one to two feet, and it is web-footed. The flesh of this is not inferior to that of the green turtle.

2246. *The crocodile* is eaten by the natives of some parts of Africa; but European travellers, who have tasted its flesh, describe it as having a nauseous musky taste, though some parts are more delicate, resembling veal.

2247. *The guana*, or *iguana*, is a lizard four or five feet long, an inhabitant of South America and Africa, and sometimes met with in the West Indies: it is gentle and harmless, and so much prized on account of the delicacy of its flesh, that it has become rare in many places where formerly it abounded. Stewed guana is a favourite dish in the West Indies. Its eggs are a great dainty.

2248. *Various other lizards* are eaten in different parts of the world, and none of them are injurious as food.

2249. *The frog* (*Rana*, Linn.), which is so frequently eaten in France and many parts of the Continent, and which we hear so much about, is not our common frog, but another species somewhat larger, the *Rana esculenta*, Linn. It is of a green colour, spotted with black, and having two pale yellow lines down the back. It is the hind quarters only that are eaten, and these are more fleshy than the thigh of our common frog, resembling the most delicate chicken; when fricasseed or made into patties, it makes a most excellent dish, which, however, in Paris is by no means cheap. The livers and fore legs are used in soup. They are brought alive in thousands to the capital cities of France, Belgium, Germany, and Italy, and in some places there are regular conservatories for keeping them alive. This frog is rare in England.

2250. We are told by Montfort, a French naturalist, that frogs are much in request at Vienna, where not only the thighs are eaten, as in France, but every part of the animal. At the commencement of winter the dealers in these creatures fill a pit with thousands of frogs, which the country people collect in the marshes and ponds, and cover them with straw and planks to keep them from the frost. In this manner they are preserved alive to supply the market as required, and there are few individuals who in the winter season do not occasionally regale themselves with a few dozen of these reptiles, which are made into dishes highly prized by the gourmands. There are even some houses where they may always be had in the choicest condition, dressed with the greatest care, and sold at a great price.

2251. *The common frog* is much inferior, but is also eaten occasionally, and is sometimes fraudulently substituted for the other species.

2252. *The bull frog* (*Rana taurina*, Linn.) of warm climates is considered equal to the turtle.

2253. *The toad* is often here supposed to be poisonous, though this is doubtful: it is a very harmless creature; but, from its ugliness, excites disgust, and is not desired as food. Among the negroes, however, it is said to be eaten without any bad consequences.

2254. *Insects.*—Few insects are used as food. The *locust* is, however, consumed in great quantities, which affords some compensation for the ravages it occasions. In Abyssinia, and among the Moors of Barbary, they are eaten both fresh and salted, and some are dried in the sun. Niebuhr informs us that in Arabia they preserve them in the same manner, and they consider them a delicacy, their taste resembling that of a crayfish. Among the natives of South Africa they are made into a kind of soup. Diodorus Siculus describes the natives of Ethiopia as feeding upon locusts. This explains what we are told of John the Baptist, who lived upon locusts and wild honey. Many insects, however, are of a poisonous nature, and it is remarkable that, as we descend in the grades or classes of animals both of land and sea, the number increases of those which are unfit for human food.

CHAPTER VII.

ON VEGETABLES USED AS FOOD.

Sect. I.—General View of the Constitution of Vegetables.

2255. *The larger portion of the food consumed by the human race is, perhaps, derived from the vegetable kingdom.* We learn from the sacred writings that vegetable food was the first employed by mankind; and ancient profane writers, as Diodorus Siculus, Ælian, and Pliny, represent the primeval races of mankind as ranging over the fields and woods in search of fruits and wild herbs. Wild pease and acorns are mentioned as constituting the greatest part of the food of the first inhabitants of Greece. The cultivation of corn, which is by Hesiod ascribed to Ceres, was an important step in civilization; and divine honours were paid to her on that account. In warm climates, fruits and other kinds of vegetable nutriment are produced spontaneously in great abundance, and several nations at present subsist almost solely upon this diet.

2256. *Only a small part of the numerous tribes of plants are, however, available for food in their natural state:* unlike the animal kingdom in this respect, the greater number of vegetables are useless as food, and many are extremely deleterious. The choice of vegetables, therefore, for this purpose requires more precaution than that of animals. Botanical knowledge can often point out those which may be considered as poisonous, and those which may be safely eaten; but in meeting with new or undescribed species, great caution should be used, and it may be prudent first to try their effects on quadrupeds.

Although nature supplies the inhabitants of tropical regions with abundance of vegetable food, almost without the trouble of cultivation, yet that is not the case in temperate climates. Almost all the esculent vegetables which are found in Europe have been introduced from other regions by the industry of man, and many of them may almost be considered as the produce of art, since they have been gradually brought to the state in which we now see them by the gardener and agriculturist, who, by cultivation, have metamorphosed certain wild and unsavoury herbs into the delicious and varied produce of our gardens. Many of these changes have been brought about at a very early period in the history of mankind; for instance, the originals from which the varieties of cerealia, or corn plants, have been derived, cannot now be traced by the botanist in their wild state; and yet corn supplies all the civilized world with its chief article of food. Here we perceive the advantages which have accrued to mankind from the employment of their reasoning faculties. The whole of our cabbages and cauliflowers, whose leaves alone often weigh several pounds, have been acquired by the gradual transformation of the wild colewort, a plant of scanty leaves, not weighing more than half an ounce. From the sour sloe has been produced the delicious plum, and the austere crab has been transformed into an almost endless variety of apples, possessing the richest flavours and the utmost beauty of colour.

2257. *Some vegetables undergo extraordinary changes* at different periods of their growth. While young, they may be safely eaten; yet when they attain such an age that they are capable of reproduction, they possess properties which render them poisonous if employed in the same manner, though they may be used as active medicines in small quantities.

2258. *Different species of plants vary exceedingly according to the parts which afford wholesome and proper nutriment.* In some this is found only in the seeds; in others in the leaves; in some, again, in the roots; of others all the parts may be eaten. Some are even poisonous, until they are deprived of a certain juice, and then the rest is harmless food.

The fibrous and membranous parts of vegetables are not easily digestible, or not at all. The skins of fruits in general, as of grapes, pass through the stomach unchanged; so do

the husks of pease; and corn, grains, or seeds of various kinds, often go through the stomachs of horses, birds, and other animals in a state still fit for germination, on account of the indigestibility of the husks, which points out the advantage of first boiling or soaking them in hot water till they burst. The green leaves of vegetables, though in general acting somewhat on the bowels, are apt to produce acidity and flatulence with dyspeptic persons, and are therefore less fit for them than farinaceous food.

2259. *Vegetables, though devoid of sensation, possess what is termed the living principle;* but this is of a very different kind from what we denominate the life of an animal; yet between both there are analogies which are very remarkable. Animals receive food into their mouths, from which it passes into the stomach; plants take in their food by the roots, which are their mouths. Both animals and vegetables possess a power, depending upon the vital principle, by which the food is digested, converted into nutriment, and assimilated, so as to enter into the substance of their frames. In order to this, it is made to move through a series of vessels, in which it undergoes certain alterations, by which it is transformed into several different juices adapted for different purposes in the living body. The mode in which these changes are effected is absolutely unknown to us, the chemistry of nature being beyond our power of investigation. But by these means are formed all the substances called *secretions*, whether gum and sugar in vegetables, or bile in animals. Plants are even provided, as well as animals, with a breathing apparatus, consisting of an infinity of minute pores which open upon the surface of the leaves, and communicate with the tubes that contain the flowing juices; and in both cases air is essential to the life and health of the organic being. Not only do various plants secrete different substances, but they require different kinds of food, and various temperatures, in order to flourish, as is the case with animals. Notwithstanding these points of agreement, however, the difference between the two classes is sufficiently marked in general, although certain species in each approach so near together that it is sometimes difficult to say to which of the two kingdoms they properly belong.

2260. *In considering the nature of vegetable matter as employed for food,* we shall follow the same plan as that by which we examined the nutritive properties of animal food. We shall inquire into the chemical nature of vegetables in general, and collect together those *proximate principles* into which all vegetable substances may be resolved.

2261. *It has been already stated that the elements of which all vegetable bodies consist* are carbon, oxygen, hydrogen, and nitrogen.

But nitrogen exists in the vegetable kingdom in much smaller quantity than in animals. This constitutes a marked difference between animal and vegetable matter. The former has *always* a large proportion of nitrogen in its composition; whereas, in the latter, this element is found in any considerable quantity only in particular parts of plants, as, for example, in their gluten and albumen; in many other parts it is entirely wanting, a few vegetables, as the fungi, which abound in nitrogen, being exceptions. Thus (as we have already stated, but which we here repeat for the convenience of the reader) the same elements are found both in the animal and vegetable kingdom; and the very same particles may at one time compose part of an animal, and at another time be a portion of a vegetable. There is not, therefore, as some persons might suppose, a kind of substance absolutely and permanently of a vegetable nature, but matter is only vegetable for a time. Thus, animals feed upon vegetables; and the elementary particles of which the latter consist enter as food, and are made to supply the waste in animal bodies; the particles unite with the animal substance, and become of the same kind; they are assimilated, and are now a portion of an animal. The animal dies, undergoes decomposition, and its carcass, or a part of it, mixes with the soil, and is often employed as manure to vegetables. A portion of the decomposed animal matter acts either directly or indirectly in supplying food to the roots of the plant, which it forms into wood, bark, juices, or other parts of its body. In this new condition, the particles may belong essentially to the vegetable: but they have suffered no actual change; they have only been arranged in a new form, and are differently combined. The elements we have mentioned as common to the two kingdoms are exactly of the same nature, whether they are drawn from the one or the other. But nature only can make these arrangements: human art can decompose both animal and vegetable matter into its ultimate elements, but cannot form out of them either an animal or a vegetable, nor can it change the one into the other. Nature, in forming vegetable matter, or vegetable arrangements, follows the same plan as when composing animal matter: in both cases, *proximate principles are first composed;* but the proximate principles of vegetables are different, except a few, from those of animals.

2262. *By what means plants compose their proximate principles* out of the four elements is a mystery which we cannot penetrate; it must be classed with the incomprehensible functions by which they increase and propagate their species, and with those laws by which they continue to present the same forms and qualities through innumerable generations: phenomena which cannot fail to impress upon the mind of the careful inquirer a conviction that the whole is regulated by causes and powers far transcending our

limited capacities to explain, and demonstrating an omniscient and superintending Providence.

We shall, therefore, in studying vegetable substances, have to enumerate a set of bodies called *proximate principles*, belonging to the vegetable kingdom, generally distinct from those appertaining to animals. All these exist ready formed in the plant, in the same manner as in the case of animals; and all vegetables may be resolved first into these before their final dissolution into their elementary constituents, carbon, oxygen, and hydrogen.

2263. *The proximate principles of vegetables are*:

1. Starch, or fecula.
2. Gluten.
3. Vegetable albumen.
4. Sugar, or the saccharine principle.
5. Gum, or mucilage.
6. Lignin, or woody fibre.
7. Vegetable jelly, or pectin.
8. Vegetable oils, fixed and volatile.
9. Vegetable wax.
10. Resin.
11. Balsams.
12. Gum resins
13. Camphor.
14. Tannin, or tannic acid.
15. Colouring matter.
16. Vegetable acids.
17. Vegetable alkalies.

The first five of these principles, viz., starch, gluten, vegetable albumen, sugar, and gum, constitute the principal ingredients in most of the esculent vegetables; and starch and gluten are much more nutritious than the rest.

2264. *The comparative nutritive properties of the several vegetable substances* used as food is best known by chemical analysis. It having been already determined by long observation which of the vegetable proximate principles afford the most nourishment, or tend most to the support of life by the process of digestion, chemical analysis will, by showing the relative proportions of these principles in each species of plants, enable us readily to distinguish which kind is most nutritive.

Vegetable Substances.	Whole Quantity of soluble or nutritive Matter.	Starch or Mucilage.	Saccharine Matter.	Gluten or Albumen.	Extract or Matter rendered insoluble during Evaporation.
Middlesex wheat, average crop	955	765	—	190	—
Spring wheat	940	700	—	240	—
Mildewed wheat of 1806	210	178	—	32	—
Blighted wheat of 1804	650	520	—	130	—
Thick-skinned Sicilian wheat of 1810	955	725	—	230	—
Wheat from Poland	950	750	—	200	—
North American wheat	955	730	—	235	—
Norfolk barley	920	790	70	60	—
Oats from Scotland	743	641	15	87	—
Rye from Yorkshire	792	645	38	109	—
Common beans	570	426	—	103	41
Dry pease	574	501	22	35	16
Potatoes	from 260 to 200	from 200 to 155	from 20 to 15	from 40 to 30	— —
Linseed cake	151	123	11	17	—
Red beet	148	14	121	14	—
White beet	136	13	119	4	—
Parsnip	99	9	90	—	—
Carrots	98	3	95	—	—
Common turnips	42	7	34	1	—
Swedish turnips	64	9	51	2	2
Cabbage	73	41	24	8	—
Broad-leaved clover	39	31	3	2	3
Long-rooted clover	39	30	4	3	2
White clover	32	29	1	3	5
Sainfoin	39	28	2	3	6
Lucern	23	18	1	—	4
Meadow fox-tail grass	33	24	3	—	6
Perennial rye grass	39	26	4	—	5
Fertile meadow grass	78	65	6	—	7
Roughish meadow grass	39	29	5	—	6
Crested dog-tail grass	35	28	3	—	4
Spiked fescue grass	19	15	2	—	2
Sweet-scented soft grass	82	72	4	—	6
Sweet-scented vernal grass	50	43	4	—	3
Fiorin	54	46	5	1	2
Fiorin, cut in winter	76	64	8	1	3

2265. *The preceding table, drawn up by Sir H. Davy*, and published in his excellent work "On Agricultural Chemistry," exhibits the nature of most of our vegetables used commonly as food. To form it, 1000 parts of each vegetable were analyzed, and the table states the quantity of nutritive matter extracted, consisting of mucilage or starch, saccharine matter, gluten or albumen, and extract. The first column shows the entire quantity of nutritive matter, and the difference between that and the 1000 parts consisted of water, or inert or indigestible vegetable matter, possessing the properties of woody fibre.

2266. It must not be supposed that the above proportions are always exactly the same in the vegetables described in the above table, since much depends upon their cultivation and growth; yet they are probably never very different, and the results of the analysis offer some interesting facts. They show that wheat is the most nutritive of all the vegetables in common use among us, consisting almost entirely of starch and gluten, both of them highly nutritive principles. The other kinds of grain, as barley, oats, rye, as well as pease and beans, contain a more considerable portion of gluten than other vegetables, but much less than wheat.

2267. *There is one remarkable difference between vegetable and animal substances.* The attractive power or affinity by which the particles of the vegetable proximate principles are held together appears not to be so powerful as that by which those of animal bodies are united, for slight circumstances are sufficient to convert one vegetable proximate principle into another. Thus, gum, starch, and woody fibre may be converted into sugar or into acids; but no such change can be effected upon animal matter: we cannot convert fibrin into gelatin nor into albumen.

This easy conversion of vegetable principles into each other is important to attend to; for, in consequence of this, it is often supposed that vegetables contain what they do not; a substance may be apparently drawn from a vegetable, while, at the same time, it is very certain that no such substance exists in the plant. This error happens because, during the process employed, a change takes place in the arrangement of the matter acted upon, as may be exemplified in the case of obtaining spirit or alcohol from fermented barley or carrots. No spirit exists in barley, carrots, nor in any other plant; but the spirit is formed during the fermentation.

2268. *In considering the chemical constitution of the several proximate principles of vegetables, MM. Gay Lussac and Thenard have observed a curious law*, which, though it cannot be considered as positive or free from exceptions, is yet highly deserving of attention, as assisting us in forming general views, which are always important in classifying and arranging our knowledge.

First. Water is known to consist of hydrogen and oxygen only in fixed proportions; and certain proximate principles, as starch, gum, sugar, and woody fibre, which consist of carbon, hydrogen, and oxygen, have their hydrogen and oxygen in the precise proportion necessary to form water; so that, although we cannot say that these substances are composed of carbon and water, yet they consist of carbon and the elements of water in a triple combination: hence it follows that the composition of these four bodies is so nearly the same that chemists are somewhat at a loss to say in what the chemical difference consists, although they vary so much in their actual properties; but that there is a chemical difference no one doubts.

Secondly. If the proportion of *oxygen* in vegetable substances be more than is sufficient to form water with its hydrogen, that substance will be found to have *acid* properties; and all the vegetable acids are of this kind.

Thirdly. If they contain more *hydrogen* than is necessary to form water with the oxygen, then the bodies are either *oily*, *waxy*, or *resinous*. Thus we may perceive, in the proximate principles of vegetables, three great natural groups: the *saccharine*, the *acid*, and the *oily* groups; to which may be added a fourth—an *alkaline* group—distinguished by all the substances composing it, with a very few exceptions, containing *nitrogen* in addition to the other three elements.

These groups may be arranged as follows:

SACCHARINE GROUP.	Vegetable volatile oil.	Malic acid.	Strychnia.
Starch.	Resin.	Citric acid.	Veratria.
Gluten.	Gum resins.	Tartaric acid.	Emetia.
Vegetable albumen.	Wax.	Oxalic acid.	Picrotoxia.
Sugar.	Camphor.	Gallic acid.	Solania.
Mucilage.	Extractive matter.	Tannic acid.	Synopia
Gum.	Bitter principle.	ALKALIES.	Atropia.
Lignin.	Caoutchouc.	Soda.	Conia.
Vegetable jell	Colouring matter.	Potash.	Nicotina.
OILY GROUP.	ACIDS.	Quinea.	Hyoscyamia.
Vegetable fixed oil.	Acetic acid.	Cinchonia.	Daturia.
			Colchica.

SECT. II.—STARCH.

2269. *This principle, which is also called Fecula, and the amylaceous principle*, from the Latin *amylum*, is one of the most important in the vegetable kingdom, as it constitutes the principal nutritious matter in all the farinaceous vegetables used as food. It is likewise chiefly owing to the starch of grain that malt is so well calculated for the purposes of brewing: in short, from its numerous uses, it is very necessary that we should be accurately acquainted with it.

2270. *Starch is a substance ready formed by nature*, and it exists in many plants, in the form of extremely minute globular or oval grains; but these are so small that they cannot be distinguished separately without the assistance of a very powerful microscope. These grains consist of a membrane enclosing the starchy or amylaceous mat-

ter; and it is said that they do not readily burst with the heat of the stomach, and that, on this account, all such substances, when used as food, ought to be boiled to produce this effect. When cooked, farinaceous substances (those which abound in starch) constitute food that is mild, nutritious, easily digestible, and little stimulating, consequently very fit for infancy, though not sufficiently strengthening for manhood. Starch is found in the roots of some plants, as potatoes; in the stems of others, as the palm, from which sago is extracted; in the seeds of leguminous plants, as pease and beans; but most of all, in the seeds of corn-plants, and chiefly wheat: in all these it is very nearly the same, and is united in them with gluten, mucilage, and saccharine matter.

To understand this, and some of the other important vegetable principles, a simple experiment may be made: Get some flour, and, keeping it in the hand, knead it well in a basin of cold water, while another person pours gently some more water over it until the latter no longer runs off milky and turbid. The substance that remains now in the hand will be a tenacious, elastic sort of paste called gluten, which we shall have occasion to describe afterward. If the water in which the handful of flour had been worked, and which is milky-looking, be suffered to stand still for a few hours, a very white sediment will fall to the bottom; this is the starch, which has been washed out of the flour. If the clear water standing over it be poured off, and boiled till it be nearly all evaporated, the thickened extract will be a mucilaginous substance, a little sweet; and it will contain the mucilage, or gum, and the saccharine matter of the flour. In this manner the several constituent principles of flour may be separated from each other for examination.

2271. *Common starch*, as it is found in the shops, is procured from wheat by a process nearly similar to what we have just described, and is the pure fecula we are treating of; but our object at present is not to describe the mode of its manufacture; this will be shown in Book XXII., "On the Laundry." The process for extracting the starch from any other vegetable is the same: they are all bruised and agitated in water, when the starch separates readily, and subsides; then, after standing some time, the clear water is poured off, and the starch is obtained. The starch procured in this manner from potatoes is essentially the same as that from wheat, differing only in a few slight particulars.

2272. *Starch, when pure*, is very insipid, or without taste, and of a brilliant snow-white. It will not dissolve in water, either cold or below 160°; but in water between 160° and 180° it forms an important solution, thickened into a gelatinous mass, which is the state in which it is employed for stiffening linen.

On exposing dried starch to a temperature a little above 212°, it acquires a slight red tint, emits an odour like baked bread, and is slightly soluble in cold water. When roasted in a flat vessel it becomes brown, and is converted into a substance called *British gum*, which is soluble in cold water, and used instead of gum by the calico-printers. Potato starch answers best for this purpose.

2273. *Starch, when decomposed*, or separated by chemical means into its ultimate elements, is found to consist, like most vegetable matter, of oxygen, carbon, and hydrogen; and, although it is so very different from sugar in its ordinary properties, yet, as has been already observed, it differs but little from that substance in the proportion of its constituents.

In consequence of this close analogy, *starch is very easily converted into a kind of sugar*, a fact, the importance of which will be perceived when we come to the subject of brewing, where we shall find that the formation of malt depends upon the change of the starch of the barley into sugar during the process of malting.

2274. *Starch has even been converted into this kind of sugar, in considerable quantities, by a very simple chemical process*, which consists merely in boiling it with a certain proportion of water and sulphuric acid. As this conversion is well calculated to illustrate some of the chemical changes which occur in several of the arts which we have to treat of, we give the details of the process in this place.

A pound and a half of potato-starch was kept simmering at a boiling heat in a mixture of six pints of distilled water and a quarter of an ounce (by weight) of sulphuric acid. The mixture was afterward stirred, and fresh water occasionally added to supply the loss by evaporation. After thirty-four hours an ounce of powdered charcoal was added, and the boiling resumed for two hours. The acid was then carefully saturated with lime, and the boiling continued for half an hour, when the liquor was strained through calico. The insoluble residue, after having been washed and dried, consisted of charcoal and sulphate of lime. The filtered liquor was evaporated to the consistence of sirup, and, being set aside, became in eight days a crystallized mass, resembling brown sugar and treacle. The sugar weighed a pound and a quarter. One pound of it fermented in the usual way, and afforded on distillation fourteen drachms of proof spirit.

This sugar from starch is not exactly the same as that made from the sugar-cane; it is less sweet, requiring two and a half times the quantity of cane-sugar to sweeten to the same degree, and it is not quite so soluble. It agrees in its properties with the sugar of grapes, and, like it, is capable of being converted into spirit by fermentation; it is, in fact, the very substance that affords the spirit in malt liquors. How the conversion of starch into sugar is effected is not very well understood, and we wish to avoid entering into theoretical views not yet quite established; but, as has been observed above, it is supposed that, the mutual attractions of the elementary principles of vegetable bodies being

very slight, they are made to change their situations by very slight causes, and a very minute difference in their arrangement occasions a sensible difference of properties: a fact of which chemistry furnishes many examples. Few substances, indeed, appear at first more unlike than starch and sugar; the former is very insoluble and insipid, the latter very soluble and sapid. Since, as we have stated, the elementary principles, hydrogen and oxygen, exist in the proportion necessary to form water in starch, sugar, gum, and ligneous or woody fibre, these substances may be considered as so many compounds of the elements of water with carbon, the remaining element; and since, in the processes just described, the weight of the sugar obtained exceeds that of the starch employed by ten per cent., it has been supposed that the sugar is a chemical combination of starch with water.

2275. *Nature produces the change from starch to sugar during the germination of seeds in the earth.* When, under the proper circumstances of heat and moisture, germination has commenced, it will be found that the farina, or white internal kernel of the seed, has in a great measure disappeared, and that its place is supplied by a substance having a saccharine taste. It is this peculiar sugary substance that constitutes the food of the embryo plant, and it is for the purpose of supplying this food that nature has effected the change.

2276. *Man has imitated this process* in the malting of barley for the purpose of producing fermented liquor. When we treat of "Brewing and Distilling," this subject will be entered into more fully; at present it is merely hinted at, to bring all the points into the same view; and we shall then see, also, why all the substances possessing starch may also produce alcohol or spirit; first, by the conversion of the starch into sugar, and then the latter into spirit.

2277. *But starch, or fecula, cannot be always separated,* in the manner described above, from all the plants in which it exists. Sometimes it is intimately united to mucilage and oil, as in the case of the almond, and many other kernel seeds. In such plants, all these principles become diffused in the water in an equal degree on pressure, and the fecula will not be deposited by mere subsidence; nor can it, in this case, be obtained pure in any way under these circumstances.

2278. *Starch is an extremely nutritive material,* and constitutes one of the chief ingredients in almost all the most valuable vegetables used as food by man. In many instances it is not separated from the vegetables before being employed as aliment, but, in other cases, processes are employed to extract it distinct from the other ingredients, some of which are nutritious, and others injurious.

2279. By this means various species of food have been produced in foreign countries, and are in use among us, while few persons have an idea of their origin, or their relation to common starch. Of this kind are *arrow-root,* which is the starch extracted from the tubers of a plant that grows in the East and West Indies, the *Maranta arundinacea*; *sago,* a starch procured from the pith of several species of palms; and tapioca, made from the starch of *Jatropha Manihot,* a South American plant. *Tous les mois* is a substance of this class lately brought here from St. Kitt's, and said to be the starch of the *Canna coccinea.* All these boil to a jelly like starch, and are light and nutritive. They will be described more particularly in Chapter III., Book IX., "On Bread."

2280. *From the nutritious substances which have been just mentioned,* all of which consist of mere starch, we may perceive how very important is this principle in the vegetable kingdom; but this importance will be much increased when it is pointed out, as it will be when we come to the article "Bread," that it is chiefly the starch they contain which renders all the kinds of corn and leguminous seeds so valuable as food. In these, indeed, it is combined with the other proximate principles, such as gluten, sugar, oil, &c.; but it is the starch, much more than all the rest, which constitutes the nutritious part of corn and other vegetables.

2281. *Starch has the remarkable property of assuming a blue colour,* by means of the substance called *iodine,* which is accordingly employed as a test for ascertaining its presence.

Sect. III.—Gluten.

2282. In the experiment with wheat flour which was mentioned above, when starch was separated by washing, a viscid substance remained in the hand, which received the name of vegetable gluten from its discoverer, Beccaria, on account of its resemblance to glue. It is a gray, viscid, tenacious, and ductile substance, insoluble in cold water, that may be stretched out in a manner somewhat like Indian rubber. It is found more or less in a great variety of plants, but very abundantly in the kinds of grain used for making bread. Wheat contains the largest portion of it; and this is one reason why wheaten bread is superior to that made from other kinds of grain, for gluten is the most nutritious principle, though not the most abundant, contained in vegetables. It is the gluten in wheat flour that renders it so proper for light fermented bread, by occasioning its making a tenacious paste with cold water, the viscid elastic nature of which enables the carbonic acid disengaged during fermentation to form numerous vesicles that distend the mass of dough, and produce what is called the *rising.* This will be fully explained under the article "Making Bread."

2283. But it has been shown by Einhoff that the viscid substance which we have mentioned as obtained by kneading wheat flour is not pure gluten, but consists of gluten and another vegetable principle, called vegetable albumen. They may be separated from each other by boiling in alcohol, or by kneading them with the hand in alcohol; the latter being soluble, and the former insoluble, in it.

2284. *Pure gluten*, thus obtained, is of a full yellow colour, with a slight balsamic taste and a peculiar odour; it is very tenacious and elastic, and does not dissolve in cold water; but though gluten is so nutritive, it is only so when united with other vegetable principles, for by itself it is scarcely digestible. When kept moist in a warm place it ferments, and disengages carbonic acid, but afterward gives out acetic acid, which is the cause of the sourness perceived in leavened bread; in a few days, if left to itself, it acquires a smell and taste much like cheese, then it putrefies, and gives out an offensive odour like animal matter. When exposed to the air, it gradually dries, and becomes hard and brittle, like glue, from which property it has been employed to mend broken china. It loses its tenacity entirely by boiling. Gluten, though insoluble in water alone, forms a compound with acetic acid or vinegar that is soluble in water; and this is the reason why, in the manufacture of starch, just described, the souring, or formation of vinegar, acts upon the gluten that was united to the starch, and thus removes it from the latter.

Gluten differs from all the other vegetable proximate principles, except vegetable albumen, in containing nitrogen, of which it contains from 14 to 20 per cent., and this is supposed to be the cause of its being so nutritious.

SECT. IV.—VEGETABLE ALBUMEN.

2285. *Albumen has lately been discovered to be common to the vegetable as well as to the animal kingdom, though in a smaller quantity.* In its pure state it is a thick, glairy, tasteless fluid, analogous to white of egg. It is found abundantly in the juices of green leaves, as well as in the flour from wheat. It resembles gluten considerably in its composition, containing also nitrogen, but it is soluble in alcohol, and in cold water, which gluten is not. When the juice of cabbage leaves, or other similar plants, is pressed out and passed through a cloth, it is not at once transparent, but a fine green powder is suspended in it, which will require a week to settle to the bottom: this is called green fecula, and it consists of three substances: 1, a green colouring matter, which is resinous; 2, woody fibre that has been entangled in the juice; 3, vegetable albumen. If a glass bottle filled with the green juice as soon as it is filtered, and before it has time to settle, be placed in a vessel with boiling water, the liquor will deposite a flocculent or cheesy matter, which consists of the albumen, which has coagulated by the heat; and as it resembles the white of egg, when washed and deprived of colour, it has received the name of *albumen*, though not absolutely identical with animal albumen; it appears to be sometimes a vegeto-animal substance.

It can scarcely be necessary to state that this principle contained in the juice must coagulate in the same manner as animal albumen when vegetables are boiled; and on this depends the method taken to clarify many vegetable juices.

It is found in many plants; in nuts, grains, apples, grapes, and fruit of all kinds; in flowers, young shoots of trees, green leaves, &c. It abounds in the juice of the Papau-tree; when this juice is boiled, the albumen falls down in a coagulated state; it is likewise met with abundantly in mushrooms and in different species of fungi. The principal part of the almond, and of the kernels of many other nuts, appears, from the experiment of Prout, to be a substance analogous to coagulated albumen. The juice of the fruit of the Ochra (*Hibiscus esculentus*) contains a liquid albumen in such quantities, that it is employed in Dominica as a substitute for the whites of eggs in clarifying the juice of the sugar-cane. Like gluten, it soon putrefies, particularly when kept moist, or in stagnant water. It is contained under the fibrous rind of flax and hemp, and its decomposition during steeping occasions the ready separation of the fibres, and likewise the unwholesome and offensive odour of water in which this has taken place. It is this also which occasions the disagreeable and unhealthy smell of decaying leaves of vegetables, and particularly of cabbages, and of the water in which they have been boiled. Like animal albumen, it consists of carbon, oxygen, hydrogen, and nitrogen.

2286. *Yeast, or the vegetable ferment*, which we shall see more of under "Fermentation," is supposed to be either gluten or vegetable albumen; but it does not appear to be absolutely certain whether it is one, or modification of both.

2287. *Vegetable fibrin and vegetable casein* are enumerated among the proximate principles of vegetables by some late writers; but as it does not appear certain that they are not identical with those already known and described, we avoid rendering our subject unnecessarily complicated.

SECT. V.—SUGAR, OR THE SACCHARINE PRINCIPLE.

2288. *Sugar is very generally diffused through the vegetable kingdom*; but its importance demands that it should be treated of at large in a separate part of this work. At present it is proposed to consider it only in brief as one of the proximate principles of vegetables. Sugar exists more or less in almost all vegetables, but abundantly in ripe fruits, and the

roots of the beet, carrot, &c. It is procured most plentifully, as is well known, from the juice of the sugar-cane and of the maple-tree.

2289. *There are several species of sugar* which agree in having a sweet taste, but which differ in other respects. 1. *Cane-sugar*, or common sugar, which is seen in its purest state when crystallized in white sugar-candy, and in refined sugar. Sugar from the maple-tree and beet root is the same as that from the cane. 2. *Sugar from grapes* contains less carbon than cane-sugar, and is not so sweet; it requires two and a half times as much of this sugar to sweeten to the same degree as cane-sugar; it cannot be made to crystallize distinctly, but solidifies in grains; it dissolves less rapidly than cane-sugar, and gives a more fluid sirup. Sugar of malt agrees with this, and also the sugar of honey, of raisins, figs, and many other sweet fruits. There are other varieties of sugar from various vegetables, but as they are not well understood, and not important, we need not mention them.

2290. *We have already stated that sugar can be prepared from starch*; and hence the reader may be less surprised at being informed that the woody fibre, or the wood of vegetables, a principle which will be described, has been employed for the same purpose. Persons not familiarized with chemistry may, perhaps, consider it as a piece of pleasantry to be told that sugar has been made from common wood, deal boards, sawdust, straw, and even linen rags, all of which consist of woody fibre; yet this has been effected by Braconnot through the action of sulphuric acid; but as the fact is rather illustrative of the powers of chemistry, and the nature of vegetable substances, than applicable at present to any practical purpose, we shall not enter into farther details respecting it.

2291. *The only sugar in general use in Britain* is that of the sugar-cane made in the West and East Indies; the maple-tree sugar is made and used in North America, and the beet root sugar in France. Besides the use of sugar for domestic purposes, it is extensively employed for producing ardent spirit, either pure, or in wine, beer, and all fermented liquors; and it is the only substance from which this can be procured, as will be fully explained under "Fermentation," "Brewing," "Wine-making," and "Distilling." It is likewise employed in the preservation of fruits.

There are various opinions respecting the nutritive properties of sugar. It is readily digested by the healthy stomach; but with some dyspeptic individuals it does not agree.

Sect. VI.—Mucilage.

2292. *It is usual to consider mucilage and a solution of gum in water as the same*; but Hermstadt makes this distinction: the solution of gum in water is transparent and glutinous, and can be drawn out into threads, whereas that of mucilage is opaque, does not feel glutinous, but slippery, and cannot be drawn into threads. Dr. Bostock also takes a similar view of the subject. Of mucilages there are a great variety of kinds existing in the roots, stems, leaves, and seeds of many plants. They seldom or never separate spontaneously, but may be obtained artificially in a state of tolerable purity, though it is impossible to separate them completely from starch, gluten, sugar, &c. Only a few species have been examined, and we are uncertain how far their properties agree. Linseed yields one of the purest, which is well known in what is called linseed tea; when thick, it much resembles solution of gum Arabic. Mucilage is perfectly soluble in cold and hot water, and is easily extracted by boiling, as from the roots of marshmallows, the kernels of quinces, and most bulbous roots and fleshy leaves. Many of the fuci also yield a large quantity; some lichens have so much, that they have been used for the purpose of gum in calico printing. Mucilage is found more or less in barley, wheat, and all the grains used for brewing and baking.

Sect. VII.—Gum.

2293. *Some trees suffer their gum to transude* either spontaneously or by incisions made in them; it becomes concrete by drying in the air. All gums are easily dissolved in water, and are then nearly analogous to mucilage; but they do not dissolve in spirits of wine nor in oils. They readily unite with sugar, and their composition is so analogous to it, that they are easily converted into that substance by a chemical process, which, however, is not employed, because sugar is procured more economically in another way. The uses of gum are well known. The principal gums among us are:

2294. *Gum Arabic*, the most valuable kind, which exudes from different species of mimosa, particularly the *vera*, a native of Arabia. The best is colourless, and very transparent.

2295. *Gum Senegal* does not differ much from the last, but comes to us in large pieces, and is much employed by the calico printers. It is the produce of the Acacia *Senegalensis*.

2296. *Gum tragacanth* is very different from the gums already mentioned, and is the produce of the *Astragalus tragacantha*, a thorny shrub growing in Syria and the islands in the Levant. It does not dissolve in cold water, but swells up into a mucilaginous mass, and requires digesting in hot water.

2297. *Cherry gum* is more analogous to gum tragacanth than to gum Arabic, as it dissolves in hot water, but not in cold. It exudes from the *Prunus avicum*, or black cherry-tree of this country; also from the plum, peach, and apricot-trees.

The gums are seldom employed as food, and, it is said, are not very nutritious, though the Africans in Senegal sometimes subsist upon it during the gum harvest.

Sect. VIII.—Lignin, or Woody Fibre.

2298. *This name has been given to the solid skeleton, as it may be called, of plants*, or what remains after all the principles which have been just described are separated. This skeleton is composed of an infinite number of extremely minute fibres, which are arranged in bundles, so as to constitute the various forms of stems, branches, and leaves; and these, together with the cellular or pithy part between them, make up the solid through which the juices flow. Every one has seen leaves, in the autumn and beginning of winter, decayed, so as to have only the veins or fibres remaining: this is the lignin, or wood, of the leaves.

2299. *The properties of lignin may be examined* by boiling some wood rasped, or sawdust, for a long time in water, to carry away such substances as are soluble in this fluid, and then treating it with alcohol, to dissolve the resinous principles. After this, nothing would be found to remain but a fibrous substance, without taste or odour, and which would undergo no change by keeping in the dry: this would be pure lignin, and would amount to about 96 per cent. in most kinds of wood.

2300. *The ligneous part, or lignin, of esculent vegetables is in far less proportion than in wood; yet it is never absent*, since it is necessary to form the skeleton of the plant. It is seen in the stringy part of culinary vegetables, as in many parts of the cabbage; but is most striking in the hemp and flax plants, their long fibres consisting of this very woody matter arranged round the external part of the stem.

2301. *Lignin is itself composed of* the same elements as all the other proximate principles consist of; in 100 parts there are 51·43 of carbon, 42·73 of oxygen, and 5·82 of hydrogen; and when it is burned, the oxygen, hydrogen, and part of the carbon fly off, leaving only remaining the carbonaceous part of the skeleton, in the form of charcoal.

Wood, under ordinary circumstances, as is well known, is indigestible, and unfit for food; those vegetables which have much of it in their structure are improper; and it is only the most succulent, that is, those which have much juice, or other nutritious principles, in proportion to their woody fibre, that are employed; yet the substance we are now considering is (as we have already hinted) not entirely incapable of being employed for human sustenance.

2302. We shall see under the article "Bread," in Book IX., Chap. III., that wood itself can be used in various ways to assist in increasing the quantity of nutriment; and chemistry has opened a new view of the subject, which may, perhaps, some day, extend the bounds of the vegetable kingdom to the support of life. We mention these discoveries, because, although they are not applied at present in practice, yet they are intimately connected with the subject of aliment, and the view which we are attempting to give would be altogether incomplete without noticing them.

2303. *The discoveries to which we allude were made by M. Braconnot*, a French chemist, and are described at length in Vol. XII. of the *Annales de Chimie*. If the sawdust of hard wood be mixed up with strong sulphuric acid, it will be dissolved: when the mixture has got clear, add chalk to saturate the acid; then strain off the liquor from the insoluble sulphate of lime, and boil it down to dryness. A substance will now be found in the bottom of the vessel very much like gum Arabic, and which is the produce of the sulphuric acid acting upon the lignin, or dry indigestible fibre of the wood. This substance, indeed, appears to have all the properties of gum; it is transparent and yellow, shining like gum, dissolves in water, making a viscid, adhesive paste that will join bodies together. Gum is known to be to a certain degree nutritious; and here is a new substance possessing similar properties. But this is not all. If this gum be once more treated with sulphuric acid, by mixing and heating them together, the gum is converted into sugar capable of being granulated, and which, though not of the same strength as cane sugar, would serve for the purpose of distillation, and many others. To say that these processes would be too expensive to be applied at present to any practical use is trifling; and we envy not the person who could urge the objection with a view to lessen the interest which such discoveries must excite. In the progress which mankind has been making from the rudest state, facts themselves have been first ascertained: their application has been a second step, and often very gradual and slow. But it is quite unnecessary to enlarge upon this subject: the history of inventions, and the advancement of society, present innumerable proofs of the most striking kind, that discoveries are not to be undervalued because we cannot see their immediate bearing; and if even nothing farther shall be accomplished, yet the beautiful simplicity of vegetable nature flashes at once upon the understanding, and this knowledge seems to give man a power hitherto unknown and unsuspected.

2304. *It now appears that starch, gum, sugar, lignin, and probably other vegetable principles, are so nearly allied in their composition* (as we have already pointed out), that little is necessary to cause one to assume the form and properties of the other. But here we must make a distinction, and draw the line between the feeble powers of human

chemistry and those extraordinary, but altogether incomprehensible, powers which belong to the chemistry of nature.

2305. *Starch is not merely a substance consisting of definite elements, but it is a substance having an organic structure:* it consists of minute vesicles, of oval forms, that can be seen only by a good microscope: now, though we can convert these into the substance called sugar, yet the chemist cannot bring this sugar back again to starch; though he can make sugar from starch, he cannot make starch from sugar; he cannot organize. In like manner is lignin, a most extraordinary organized substance, composed of bundles of tubes fifty times finer than a hair, the finer fibre of flax being a bundle; now lignin can be made, as we have seen, into sugar, but the latter substance cannot be brought back to the state of those minute woody fibres. We know from chemistry the composition of all those substances: we know that they all consist of carbon, oxygen, and hydrogen; elements which we can procure from mineral bodies; yet, though we have these elementary bodies in abundance, we cannot out of them compose the simplest organic body. The work of organization is altogether beyond the comprehension of the human mind.

2306. *Now it is a fact which we learn from extensive observation*, that, in order that matter shall be fitted for the food of animals of any kind, it should be prepared by having first passed through the vegetable kingdom; and that it should there have been employed in forming vegetable structures; in short, it must have been what we term an *organized* body, or a body possessed of a certain species of life, and constructed in a peculiar manner very different from mineral substances. No animal can subsist upon mineral bodies, even though they should contain nearly the same elementary principles as vegetables: these elements must have been first organized before they can constitute food for an animal. Vegetables can extract food from mineral substances, and prepare it for animals, by first converting it into their substance; after this, the same matter may be introduced into the animal system, and undergo such farther modification as to be *animalized;* it now passes into the animal kingdom, and is capable of affording sustenance to this higher class of beings. Here, then, is a part of that beautiful order and gradation which we discover in every part of creation. This chief use of vegetable life, that of conducting to a higher order, may seem to be contradicted by animals feeding upon each other; but, on closer examination, it will be found that this exception is more apparent than real, as we may observe that carnivorous animals live upon those that feed upon vegetables, so that still we trace that the entrance of matter into the living system is through the vegetable kingdom.

2307. *A bar seems, therefore, opposed to the extent of our chemical power;* we cannot by its means increase the quantity of organized matter; but it is evident that human knowledge and art have already wonderfully modified the nature of organized matter, so as to render available as food much that in its natural state was unfit; of which the arts of agriculture and of cooking furnish eminent examples.

2308. *In prosecuting these researches, Braconnot was desirous of trying how far* the changes from lignin to sugar could be effected, and whether every condition of this principle could be so converted. For this purpose he tried, not only sawdust, but, with equal success, hemp, straw, and even linen rags and paper, all of which consist of lignin, and all of which he converted into sugar.

2309. *But it is now many years since that Professor Auchtenrieth of Tubingen showed* that, by proper management, lignin might be converted into a species of bread (Prout, *Phil. Trans.*, 1827. See receipt in Chap. III., Book IX., "On Bread"). "This discovery," Sir John Herschel observes, "which renders famine next to impossible, deserves a higher degree of celebrity than it has obtained." And lest it might be supposed, in what we have said above, that there is a certain dash of the extravagant, we shall beg leave to quote a few farther remarks from the authority we have just cited, whose practical as well as enlarged views no one will dispute. "The transformations of chemistry, by which we are enabled to convert the most apparently useless materials into important objects in the arts, are opening up to us every day sources of wealth and convenience of which former ages had no idea, and which have been pure gifts of science to man. Every department of art has felt their influence, and new instances are continually starting forth of the unlimited resources which this wonderful science developes in the most steril parts of nature. Who, for instance, would have conceived that linen rags were capable of producing *more than their own weight* of sugar by the simple agency of one of the cheapest and most abundant acids; that dry bones could be a magazine of nutriment capable of preservation for years, and ready to yield up their sustenance in the form best adapted to the support of life, on the application of that powerful agent steam, which enters so largely into all our processes, or of an acid at once cheap and durable; thus, sawdust itself is susceptible of conversion into a substance bearing no remote analogy to bread, and though less palatable than that of flour, yet no way disagreeable, and both wholesome and digestible, as well as highly nutritive?"

Notwithstanding these announcements, however, it is but just to add, that some persons think it possible that the apparently nutritive properties of lignin, as treated by Professor Auchtenrieth, might have been partly owing to some starch which generally accompanies the woody fibre; and we have said so much, rather to show the power of chemistry as applied to our subject, than as anything of great practical advantage.

SECT IX.—VEGETABLE JELLY.

2310. Several vegetables, but particularly ripe fruits, as currants and gooseberries, yield a juice by pressure, which, when carefully evaporated at a temperature of 200°, the concentrated portion of it concretes into a tremulous gelatinous mass, quite distinct from animal gelatin, and from gluten, as it contains no nitrogen. This substance is well known by the name of *jelly*. It is scarcely soluble in cold water, but very soluble in hot

water, and when cold, again coagulates into the form of jelly. When long boiled, it loses the property of gelatinizing by cooling, and becomes analogous to mucilage. This is the reason that, in making currant, or any other vegetable jelly, when the quantity of sugar added is not sufficient to absorb all the watery parts of the fruit, and, consequently, it is necessary to concentrate the liquor by long boiling, the mixture often loses the property of gelatinizing, and the jelly, of course, is spoiled. Vegetable jelly exists more or less in all ripe acid fruits, as the orange, lemon, gooseberry, &c. It is considered very analogous to gum with vegetable acid.

To procure the jelly free from the acid, if the jelly which has gelatinized be put into a sieve, the acid gradually filters through, and, by washing with water, may be separated, leaving the jelly pure; this will dry into a hard mass, not very different from gum. Braconnot, who first observed this fact, proposes the name of *pectin* for the substance.

SECT. X.—VEGETABLE OILS.

2311. *Oil is distinguished by its peculiar unctuous feel, by its inflammability, and refusing to mix with water.* Animal oil has been described as "Fat," Chap. II., Book VII. The vegetable oils are divided into fixed and volatile. They are called *fixed* when the greasy stain which they give to paper does not disappear on the application of heat, and when they do not rise in distillation at the temperature of boiling water. *Volatile* oils are those whose stain on paper disappears with a gentle heat, and which, when distilled with water, rise at the temperature of 212°. The fixed vegetable oils form a numerous and important class.

2212. *Fixed Vegetable Oils.*—These exist ready formed, and uncombined with any other substance, in the kernels of many seeds. They are also found in the roots, bark, and wood; but there they are intimately combined with other principles of the plants. These are usually procured from the seeds and kernels of plants by pressure; hence they are often called *expressed* oils. The substances are put into bags of hemp or hair cloth, and subjected to the action of pressing-mills, at first without heat; what is expressed first is the purest oil, and is called *cold drawn;* afterward some heat is applied, by which a second quantity is obtained of an inferior kind. By this process some mucilage is pressed out together with the oil; and as this deteriorates the quality of the oil, it is afterward, but with some difficulty, separated, and the oil is said to be purified. Fixed oils, when perfectly pure, are quite transparent, either colourless, or of a pale yellowish or greenish tinge, and without smell or taste; when they possess these in their ordinary state, it is owing to the mucilage and other matters mingled with them. They are usually fluid, but of thickish consistence, and they congeal at moderately low temperatures; some are naturally concrete. They combine readily with alkali, forming soaps.

Fixed oils do not boil by being converted into vapour until they are heated to 600°. When a sufficient heat is applied, and vapour is formed and then condensed, the condensed oil is found to have had its properties altered: it has become more limpid and volatile, having lost some of its carbon. When expressed oils are exposed to a warm atmosphere, they gradually acquire a sharp taste and smell, and become thick. This change is termed *rancidity*, and is owing to their absorbing oxygen.

2313. Fixed vegetable oils are subdivided into *fat* and *drying* oils.

2314. *Fat vegetable oils* are those which will not dry or become hard of themselves when spread on any substance, but remain always liquid, or soft and greasy, in the ordinary temperature of our climate. Fat oils, in general, will not unite with water alone; yet, by the addition of mucilage or sugar, they mix with it by agitation, and such mixtures are called *emulsions*. These oils require to be heated to 600° before they boil, and do not inflame until their temperature is elevated to this point. When exposed to the air, they become more viscid, and acquire a degree of rancidity; but when fresh, they have little or no smell; they are never perfectly transparent, but have always a slight yellowish or greenish tinge. The principal fat vegetable oils in use with us as food are olive oil, rape-seed oil, and almond oil: others, employed by us only for procuring light, as palm oil and cocoanut oil, have been described in Chap. II., Book IV., "On Artificial Illumination."

2315. *Olive oil* is so useful in domestic economy as to demand more attention. The description of the olive, from the pulpy part of which it is obtained, will be given in Chapter IX., on "Fruits." Olive oil is brought to us from Italy, Spain, and the Ionian Islands, but chiefly from the first of these countries. The best oil known in our markets is made in Florence and Lucca, and comes from Leghorn; but most of our olive oil is Neapolitan, produced in the provinces of Puglia and Calabria Ultra, and called *Galipoli oil*, from the place whence it is exported. A great deal is used by the wool manufacturers. It is produced in the following manner:

The oil is contained in the pulpy outside of the fruit, whereas most other fruits have their oil in the nuts or kernels. The olives are gathered ripe in November, and immediately bruised in a mill, the stones of which are set wide enough not to crush the kernel; the pulp is then subjected to the press in bags made of rushes. By the first

gentle pressure the best, or *virgin* oil, is obtained; and by increasing the pressure so as to break the kernels, at the same time moistening the residuum with water, and applying sometimes a slight degree of heat, a second quality is procured, which, though mixed with the water, on being suffered to remain undisturbed, soon separates, and, although inferior to the first, is still fit for the table. Sometimes a third quality is produced by boiling the pressed cakes in water, and skimming off the oil; this is used by the soap-boiler and other manufacturers. Much depends, not only on the quality of the fruit, but also on its being exactly in the proper degree of maturity; if not sufficiently ripe, the oil has a bitterish taste; if too ripe, the oil is fatty. After the oil has been expressed, it is necessary that it be separated from the mucilaginous matter that accompanies it. For this purpose it is suffered to rest till the mucilage and impurities subside, and the oil is found upon the top. If it be immediately put carefully into clean glass flasks, and secured from the air, it undergoes no farther change. The common oil put into casks cannot be preserved above a year and a half or two years. The oil used for the table is sometimes adulterated with poppy oil. This fraud may be detected by exposing the oil to a freezing cold: the olive oil will congeal, while that of poppies will remain fluid. But a contamination of a pernicious kind by lead is said to occur from its having been kept in leaden cisterns, either in Spain, where this is practised, or in this country. Good olive oil should be inodorous, insipid, soft, and agreeable in the mouth. Its analysis, according to Gay Lussac and Thenard, is, in 100, carbon, 77·21; hydrogen, 13·3; oxygen, 9·4.

2316. *Rape-seed oil* is extracted from the *Brassica napus* and *campestris*. It is made chiefly in Flanders, where it is used for the table, and is said to be employed for adulterating olive oil; but though very pleasant when quite fresh, it is liable to become rancid.

2317. *Almond Oil.*—This oil being united to much albuminous and mucilaginous matter, easily mixes with water, and forms emulsions, for which purpose it is much employed in pharmacy. The oil is obtained by expression from the fruit of the almond-tree (*Amygdalus communis*). When pure, it is perfectly inodorous, and of an agreeable taste.

2318. *Castor oil*, obtained from the seed of *Ricinus communis*, or *Palma Christi*, is used only medicinally.

2319. *Many fixed vegetable oils do not remain liquid in our ordinary temperatures*; some of them are called *vegetable butters*. These are very numerous; but the principal ones known to us are *palm oil*, from the palm; *cocoanut oil*, from the kernels of the cocoanut; *butter of cacao*, procured from the kernels of the *Theobroma cacao*, or chocolate nut. These oils, which are solid with us, but always soft or liquid in warm climates, are employed in India and Africa as substitutes for butter in cooking, and also for making candles. See Book IV., "On Artificial Illumination."

2320. *Drying oils*, when exposed to the air, acquire a pellicle on the surface; and if they are spread in a very thin layer, they harden and become solid, resembling resinous bodies, from the absorption of oxygen: on which account they are employed to mix with colours in painting, which the fat oils will not serve for, on account of their not drying. The principal drying oils are linseed oil, poppy oil, nut oil, hempseed oil.

2321. *Linseed oil*, from the seeds of the flax plant (*Linum usitatissimum* and *perenne*). The seeds are generally roasted before the oil is expressed, for the purpose of drying up the mucilage; it is only used in oil painting and in varnishing.

2322. *Poppy oil*, extracted from the seeds of *Papaver somniferum*, is much cultivated in France, Holland, and Germany for this purpose. It is clear and transparent, and dries readily; it is therefore employed in painting; when pure, it is without taste or odour. It is occasionally also used for the same purposes as olive oil, having none of the narcotic qualities of the poppy.

2323. *Hempseed oil*, made from the seed of the hemp (*Cannabis sativa*), is sometimes employed in painting; but in Russia it is extensively used as food, though its taste is harsh and disagreeable.

2324. *Nut oil*, from the fruit of *Corylus avelana*, is used in this country only for painting; but in the middle departments of France it is employed as a seasoning for food; it is apt to become rancid.

2325. *The drying quality of these oils is increased by boiling*, before which they are said to be *raw*. The method of boiling for this purpose has been described in Book I., under "House Painting."

2326. *Resins and natural balsams are dissolved by fat oils*, with the assistance of heat; and these oils, united to the fixed alkalies, make *soap*, an article of such importance as to demand a separate description in a subsequent part of this work. See Book XXII.

2327. *Volatile oils*, called also *essential oils*, are obtained from various parts of aromatic plants, as the flowers, leaves, bark, wood, and roots, rarely from the seeds, which mostly contain fixed oils. When these oils exist in the plants in great abundance, and are contained in cells near the surface, they are sometimes procured by simple expression, as is the case with the oil which lies in the rind of oranges and lemons; but the

greatest number are procured by distillation as they rise, or are converted into vapour at the same heat as water, 212° ; hence their name *volatile;* for, as we stated, the fixed oils require 600° to make them volatilize or change into vapour. The parts of the plant containing the volatile oil are put into a still with a quantity of water, and a moderate heat is applied. The oil is separated, rises with the aqueous vapour, and is condensed with it. Most of these oils, being lighter than water, swim upon the top; a few are heavier, and sink to the bottom. The volatile oils have not the unctuous quality of the fixed oils, but are generally as liquid as water, though a few are somewhat viscid. They have an acrid and burning taste, and an odour extremely powerful, often very fragrant; the delightful odour of flowers proceeds from the evaporation of the essential oils, which are formed and are contained in their cells.

They are soluble in strong alcohol, and hence the *essences* of perfumers; but, on adding water to the solution, they are precipitated. They unite with water in a small quantity, which takes place in the above-mentioned process of distilling them; and this union constitutes the distilled waters of pharmacy. From their great volatility, and having no fatty qualities, the stain which they make on paper when dropped upon it disappears altogether when held near the fire, if the oil has been quite pure: if a greasy spot remain, it has been mixed with fixed oil.

They do not unite readily with alkalies, like the fixed oils, forming a species of soapy compound called by the French *savonules*. When exposed to the air, they thicken from the absorption of oxygen. The most abundant and useful of the essential oils is the oil of turpentine, obtained by distillation from the natural juice, in which it is combined with resin in the fir tribe. Most of these oils are employed in pharmacy or as perfumes. Among the latter are the essence of jasmine, violets, roses, bergamot, &c. (See farther, "On Distilled Waters and Oils," Chap. III., Book XX.) Oil of turpentine has been described in Book I., among the materials for painting.

Sect. XI.—vegetable wax.

2328. *A species of wax is a product of the vegetable kingdom*, and may be extracted in considerable quantities from various plants. The varnish which appears upon the surface of many leaves consists of this substance, and it is found also in the pollen of flowers, from which, and its analogy to the honeycomb, it has been supposed that the bees only collect their wax from the vegetable kingdom; but it has been shown by Opperman (*Ann. de Chim.*, xlix., 240) that animal and vegetable wax differ somewhat in their constituents; and Huber found that bees made wax when fed upon sugar only. Hunter also pointed out that the substance which the bees procure from the pollen is not wax, but a substance which they gather for the bee-maggots, and called *bee-bread.* Bees' wax, therefore, is an animal substance secreted from the organs of the bee, as has been mentioned under "Artificial Illumination."

2329. *Vegetable wax may be regarded as a fat oil*, having become concrete by the absorption of oxygen in a natural state: accordingly, we find in different vegetables various degrees between oil and solid wax, which constitute the vegetable *butters*, as the butter of cacao; when they become more solid, they are called vegetable *tallow*, as the tallow of croton; when it is very solid, it takes the name of wax, as the *myrtle wax* of America, extracted from the seeds of *Myrica cerifera*, and the *pela* of the Chinese.

The varieties of vegetable wax employed in artificial illumination have been already described in Chap. II., Book IV.

Sect. XII.—resin.

2330. *Resins are solid substances of vegetable origin*, highly inflammable, giving much soot by combustion; insoluble in water, but soluble in essential oils and in alcohol. They are supposed to be volatile oil saturated with oxygen, in the same manner as wax is thought to be fixed oil with oxygen. They often exude spontaneously from trees, sometimes from their artificial wounds, and are generally, at first, combined with volatile oil, from which they may be separated by distillation. Common resins may furnish a good example of this. Every one has seen a yellow, transparent, highly viscous substance, called *turpentine*, occasionally exuding from deal or fir. This substance consists of the essential oil of turpentine holding in solution common resin. Large quantities of this are produced from the *Pinus sylvestris*, or Scotch fir, in the north of Europe, where there are vast forests of it; and by distillation the common oil of turpentine (improperly called spirit) is drawn off, leaving behind masses of the yellow resin in the solid state. *Venice turpentine* is procured from the larch (*Pinus larix*). *Tar* and *pitch* are also made from the pine and fir tribe; but to form tar, the logs of wood are cut down and exposed to a strong heat in tar-furnaces, by which the turpentine is partly decomposed and converted into an empyreumatic pitchy oil, called tar; and the latter, when inspissated by boiling it, pitch. The term gum is improperly applied to many substances which are resins, as gum mastic, gum sandarach, gum copal, &c. Gums are soluble in water, while these substances are not, but only in spirits of wine.

2331. *Gum resins* are substances intermediate between gums and resins. If they be

digested in water, the gum dissolves and leaves the resin; and when they are digested in spirits of wine, the resin dissolves and leaves the gum. If they are digested in a mixture of alcohol and water, great part of both resin and gum is dissolved. Under gum resins are comprehended aloes, asafœtida, gamboge, myrrh, guaiacum, &c.

2332. *Balsams* are both fluid and solid. They consist of resin, volatile oil, and benzoic acid, without the last of which they are not balsams. The terms *Canada balsam* and *copaiva balsam* are improper and obsolete, these substances not being balsams. *Benzoin, tolu, Peruvian balsams*, are real balsams.

Sect. XIII.—Camphor.

2333. *Camphor appears to possess* some of the properties of a concrete volatile oil; but it is a matter quite distinct from all other bodies. It is solid, white, and transparent; friable, but not easily pulverized; has a peculiar penetrating fragrant odour, and a bitterish acrid taste, followed by a sensation of coldness in the palate. It is extremely volatile and combustible, giving out much smoke, swims on water, and is scarcely dissolved by it, though it is easily by alcohol.

Camphor exists in a greater or less quantity in the roots, branches, and leaves of many plants, particularly in the essential oils, as the oils of rosemary, marjoram, sage, and lavender. But what is brought to this country, and used in medicine, is procured by distillation from the roots and smaller branches of the *Laurus camphora* and *Sumatrensis*. From its volatility, it is soon dissipated when exposed to the air; and if enclosed in a glass vessel, its vapour crystallizes on the inside. When thus diffused through the air, it acts as a poison to many insects; hence its use in defending clothes from moths. It is poisonous to all animals taken into the stomach in large quantities, although, like many other poisons, it is useful in very small quantities when employed medicinally.

Sect. XIV.—Tannin, or Tannic Acid.

2334. *Tannic acid has been frequently named the astringent principle*, and is very abundant in the barks of trees, and in all plants that are of an astringent nature. It exists abundantly in the bark of oak, and in large quantity in the excrescences called gall-nuts on several species of oak. It is found also plentifully in tea, sumach, and whortleberries; but in these it is always associated with gallic acid: in catechu and cinchona bark it exists in the greatest abundance, and without gallic acid. When tannic acid is prepared quite pure, it is highly astringent, and soluble both in water and alcohol. It is white, and without odour, but on exposure to air it becomes brown, as it is generally seen. Though it is itself soluble in water and alcohol, it has the useful property of forming with gelatin a compound not soluble in water; in fact, rendering gelatin, which is a very soluble substance, insoluble; hence the use of bark in making leather.

2335. *To make leather*, skins, which consist almost entirely of gelatin, are steeped in the tan-pit with a quantity of bark, chiefly of the oak; they thus become converted, by combination with the tannin, into a substance insoluble in water, and this, after going through certain operations, constitutes that useful material, leather, which is no longer liable to putrescence. A great deal of tannic acid exists also in red port and in coffee. Dr. Thomson is of opinion that tannic acid, like most other vegetable substances, is susceptible of different modifications, and that what is procured from different plants is not exactly of the same quality independently of the quantity. 100 parts of tannic acid are composed of carbon, 52·69; oxygen, 43·45; and hydrogen, 3·86. By some it is arranged among the vegetable acids.

Sect. XV.—Colouring Matter.

2336. Peculiar substances exist in vegetables called colouring matter; but this rarely or never occurs in an insulated state, being always attached to some other proximate principle, such as mucilaginous, resinous, or other substances, by which their solubility is affected. For these, see Chap. XI., Book XVII., "Dyeing."

Sect. XVI.—Vegetable Acids.

2337. *Acids form a class of substances having peculiar properties. They are sour to the taste, and they change vegetable blues to red.* The latter property is the surest and most delicate test, for it may happen that an acid may be diluted so much with water that its sourness is not sensible to the taste; but if a little of the decoction of red cabbage, which is blue, be dropped into it, the colour will instantly be changed to red: or, if pieces of paper died with vegetable blue be dipped into a liquid supposed to contain an acid, the same change will be effected. Paper coloured blue by litmus is kept by chemists for this purpose, under the name of *litmus test paper*.

2338. *Another property possessed by acids is*, that when they are united to an alkali, salts are formed that are neither acid nor alkaline, and hence called *neutral salts*. The acid and alkali in this case are said to *neutralize* each other.

2339. Of acids, some are formed by chemical action among mineral bodies, as nitric acid, sulphuric acid, &c.; these are called *mineral acids*; but at present we propose con-

sidering only such of the vegetable acids as exist ready formed in plants, and which enter into the composition of materials employed as food.

2340. The researches of modern chemistry of late have greatly added to the number of vegetable acids; but some are extremely rare, and could only find a place in a system of chemistry which should contain an account of every known substance. The following are the principal vegetable acids: acetic acid, malic acid, citric acid, tartaric acid, oxalic acid, and gallic acid.

2341. *Acetic acid* exists ready formed in the juices of many plants, either in a separate or free state, or combined with lime or potash, forming salts. It is an abundant product of the acetous fermentation, and it is also formed by the destructive distillation of vegetables, as in the case of wood vinegar. Common vinegar is an impure acetic acid; but this being an article of great importance, it will be treated of at large in another part of this work. See Chap. VI., Book VII.

2342. *Malic Acid.*—This acid derives its name from the apple, in which it abounds, particularly before they are ripe: it is likewise found in many other fruits, together with other vegetable acids, and is almost the only one in the service-tree (*Sorbus aucuparia*), from which it is sometimes called the *sorbic acid*. When pure it is exceedingly sour.

2343. *Citric Acid.*—This acid exists naturally in many acidulous fruits, but in the greatest quantity in the juice of the lime and lemon, from which it is now obtained pure in a crystallized state. The crystals are transparent; if kept dry, they may be preserved for any length of time, and are sometimes employed as a substitute for lemon-juice.

2344. *Tartaric Acid.*—This exists in several acidulous fruits, particularly the grape and the tamarind, but always combined with lime or potash; and these combinations are neutral salts, called *tartrates* of lime or of potash. The juice of the grape is remarkable for containing abundance of the bitartrate of potash; and during the process of making wine this salt is deposited in the form of a hard crust, and particularly on the sides and bottom of the wooden casks in which the wine is kept to depurate. This substance is called *tartar*, and being impure, and coloured by the wine, it is dissolved and purified; it is then white, and becomes the acidulous substance called *cream of tartar* of the shops. From this the pure *tartaric acid* is prepared by separating the potash from it by a chemical process. When the tartar of the wine-casks is burned to ashes, the tartaric acid is driven off, and the potash remains, which was formerly known under the name of *salt of tartar*.

2345. *Oxalic Acid.*—This acid, so violent a poison in its pure state, abounds in wood sorrel (*Oxalis acetosella*); but it is there combined with a small quantity of potash, and in that case it is not poisonous. When this salt, the oxalate of potash, has been prepared from sorrel, it is sometimes sold, under the improper term of *salt of lemons*, for taking out iron moulds and ink spots, for which purpose it answers equally well.

The resemblance of oxalic acid to Epsom salts has occasioned many fatal mistakes. In cases of poisoning by this substance, the best antidote is chalk or whiting mixed with water, which is preferable to emetics, or potash, soda, or magnesia, which have been also employed. Oxalic acid is easily distinguished by its strongly *acid* taste (and it may be *tasted* without danger), whereas Epsom salts have a *bitter saline* taste.

2346. *Gallic Acid.*—This acid is found in the bark of many trees, and in gall nuts, but always associated with tannin, or tannic acid, already described. It has but a very weakly acid taste, and is astringent and bitter. It is particularly remarkable for striking a deep bluish-black with iron, and from this property it forms the basis of writing ink.

2347. *Prussic Acid.*—This, in modern chemistry, is called the *hydrocyanic acid;* but it is still popularly known by its former name, which was derived from its being a constituent of the pigment Prussian blue. It is one of the most virulent poisons known, a drop or two laid on the tongue being sufficient to occasion death; but, like most poisons, when employed in very minute quantities, it is a useful medicine. It is introduced here only to correct a general opinion respecting it, which now proves to be erroneous, in consequence of the recent discoveries in vegetable chemistry. Although Prussic acid is procured by the distillation of the leaves and kernels of the *Prunus Lauro-cerasus*, or cherry laurel, *peach*, and *bitter almond*, it does not exist, as has been supposed, ready formed in these vegetables. They only contain the ultimate components called *amygdalin* and *emulsin*, from which Prussic acid is formed by their mutual action and that of water during the process of distillation. By this process, a poisonous essential oil, called by chemists *hydruret of benzueli*, is likewise formed from the same ultimate components; and it is to this essential oil, and not to the Prussic acid, that the odour of the peach-blossom is owing. Prussic acid, therefore, being merely the product of a process, cannot be considered as one of the proximate principles of vegetables. See farther, in the description of the "Cherry" and "Peach," Chap. IX., Book VII.

The composition of hydrocyanic acid is very different from acids in general; instead of oxygen, hydrogen is its acidifying principle: it is composed of hydrogen and a gaseous body called *cyanogen*, the latter consisting of nitrogen and oxygen.

Sect. XVII.—Vegetable Alkalies.

2348. *Alkalies constitute a peculiar class of bodies*, which, however, it is difficult to define accurately. They are distinguished by a peculiar *nauseous taste, called alkaline*, and which, as it cannot be described, may be understood by tasting carbonate of soda: they change vegetable blues green, and yellow ones to brown, and they neutralize or destroy the action of acids, and, consequently, restore the blue colour of such vegetable solutions as have been rendered red by them. The most convenient tests for an alkali are slips of paper dyed yellow with turmeric, and sold for the purpose by chemists: if put into any liquid containing *free* alkali, they will be changed to *brown*.

2349. Formerly there were but three alkalies known: soda, called mineral alkali; potash, the vegetable alkali; and ammonia, the volatile alkali: the first two were named, also, *fixed* alkalies. The terms mineral alkali and vegetable alkali, though formerly employed, and constantly met with in old books, and therefore introduced here, are now laid aside as not applicable, since both of them are found in abundance in the mineral and in the vegetable kingdoms. The two *mineral* alkalies, soda and potash, have for their bases peculiar metals, called sodium and potassium; these alkalies are, in fact, oxydes of the metals.

2350. *What are in modern chemistry denominated the vegetable alkalies* are certain substances existing in plants that are possessed of alkaline properties; but they are very different from the fixed alkalies just mentioned, for they do not consist of metallic bases, but are composed of the usual elements of which vegetables are formed. It is interesting to observe that, in all these vegetable alkalies, as has been already noticed, nitrogen is found in considerable proportion, contrary to what is the case in the other proximate principles of the vegetable kingdom.

Soda and potash, though differing altogether from these, being metallic oxydes, occur in abundance in plants; and, although they do not come under the denomination of vegetable alkalies, as the term is now understood by chemists, yet we feel it will be useful to describe them in this place as constituents of vegetables, premising that they must not be confounded with those vegetable alkalies which are not metallic oxydes.

2351. *Soda was called the mineral alkali* because it was originally dug up out of the ground in Africa and other countries; this state of carbonate of soda is called *natron*. But carbonate of soda is likewise procured from the combustion of marine plants, or such as grow on the seashore. *Kelp* is a substance produced by the burning of the fucus or other sea-weeds, and contains much impure soda; it is used in making glass and soap. *Barilla*, a purer kind of the same substance, is made by burning the *Salsola soda*, a plant that grows abundantly at the seaside in Spain. These carbonates of soda, when purified, are much in request by the laundress. (For its use, see Book XXII., "Economy of the Laundry.") Pure carbonate of soda is employed for making effervescing draughts with lemon juice, citric acid, or tartaric acid. Soda, deprived of carbonic acid and every other substance by a chemical process, is called *caustic*, or *pure soda*. Common salt is muriatic acid and soda, or muriate of soda, according to the late nomenclature of chemistry; but at present it is considered to be chloride of sodium, or the elementary principle chlorine united to the metal sodium; consequently, having no oxygen in its composition. It is remarkable that the metal sodium is never met with by itself in nature; having so greedy an attraction for oxygen, that when procured pure by art it falls into the state of an oxyde in a short time; and this oxyde is *caustic potash*.

2352. *Potash was formerly called the vegetable alkali*, because it was obtained from the ashes of land vegetables. When the ashes are mixed with water, the potash is dissolved, and the earths and impurities settle to the bottom. This water is then evaporated by boiling in iron vessels; and the solid substance that remains is the *potash* of commerce, so called from the manner of its production. When this is strongly heated in a furnace, it becomes whiter, and is then *pearlash*. These substances, however, are not the pure alkali or potash; for they are thus united to carbonic acid, being, in fact, *carbonate of potash*. Potash deprived of the carbonic acid by another process is called *caustic* potash, which instantaneously acts upon and corrodes animal substances, and is used by surgeons in their operations. United to carbonic acid in the usual way, it is called *mild* potash, and still preserves somewhat of causticity, as may be observed from its effects upon the skin in washing. Potash, both mild and caustic, is an extremely useful material, being employed in medicine, and for domestic purposes in a great variety of ways, which will be described under their several heads. Potash is also extensively employed in the manufacture of soap, in bleaching, scouring wool, &c. It is principally manufactured in America, Russia, and Poland, where the vast forests furnish an inexhaustible supply of ashes. Small quantities are also made here in country places from the burning of vegetables, particularly fern in mountainous districts; and *wood ashes* of any kind contain potash, to which they owe their detergent quality. *Salt of tartar* has been mentioned as an impure carbonate of potash. See, farther, Book XXII., "Economy of the Laundry."

2353. We will now say something of the most remarkable of those substances to which the term vegetable alkalies is at present restricted.

2354. *Morphia.*—It is well known that certain plants, as opium, possess a principle that induces sleep, called the narcotic principle, and which, if taken in a large quantity, occasions death. This principle has lately been detached from all others, and named Morphia, from Morpheus, the god of sleep. It is now ascertained that morphia, if employed as a medicine in lieu of opium, produces the soothing effects of that drug without the usual feverish excitement, heat, and headache.

2355. *Quinia and Cinchonia.*—These alkaline substances are supposed to contain the febrifuge virtues of Peruvian bark, from which they are extracted. United to sulphuric acid, forming sulphate of quinia and cinchonia, they are considered as more efficacious than the bark itself.

2356. *Strychnia*, a substance extremely poisonous, is extracted from the fruit of the *Nux vomica*, St. Ignatius's bean, and other plants of the genus Strychnos.

2357. *Veratria*, another poisonous substance found in the root of white hellebore (Veratrum album) and meadow saffron (Colchicum autumnale), which last, also, contains colchica.

2358. *Emetia*, a principle extracted from ipecacuanha, and which is the cause of the emetic properties of that root.

2359. *Picrotonia*, the bitter poisonous principle of the Cocculus indicus.

2360. *Solania*, the poison of the woody night shade.

2361. *Cynopia*, procured from the lesser hemlock (Æthusa Cynapium).

2362. *Conia*, from hemlock (Conium *maculatum*).

2363. *Atropia*, from belladonna (Atropa *belladonna*).

2364. *Hyoscyama*, from henbane (Hyoscyamus *niger*).

2365. *Daturia*, from stramonium (Datura *stramonium*).

Sect. XVIII.—Bitter Principle.

2366. It was formerly supposed that there was *one peculiar principle* that occasioned the bitter taste, and which was the same in all plants; but chemists are now of opinion that there is no such determinate principle common to all vegetables; and that the bitter taste proceeds from principles varying, perhaps, in each plant. There are therefore various bitter principles which have different properties. The bitter is intense in quassia, and is called *quassin*. Dr. Thomson thinks it is probable that hops, gentian, and broom contain the same bitter principle. Another called *caffein* is found in coffee. *Scillitin* is the bitter principle of squills. Many varieties of the bitter principle are deadly poisons, as *strychnia*, the bitter of the Nux vomica; *morphia*, of opium. *Nicotin* is a poisonous principle extracted from tobacco. It is important to notice these facts, since very erroneous reasoning has been founded upon the supposition that there was one distinct bitter principle having always the same properties.

Sect. XIX.—A few other Vegetable Principles.

2367. *Extractive Matter.*—In works on chemistry this term has been often employed to express a peculiar supposed principle existing in plants; but Dr. Turner and other chemists observe that it is now doubted whether there be any distinct substance to which the name ought to apply. The term *extract* in pharmacy originally meant any substance extracted by means of some menstruum: and therefore it varied according to the nature of that menstrum; thus, there were *watery extracts* and *spirituous extracts*, since many of the vegetable principles are soluble in water, others, as resins, only soluble in alcohol. From the descriptions given of what has been termed extractive, it appears to be very analogous to some of the bitter principles, which are not yet well understood.

2368. *Caoutchouc.*—This very singular substance, commonly known by the name of Indian rubber, was, not many years ago, used only to rub out black-lead pencil marks; at present, its uses are very extensive, and it will be noticed in various places through this work. (See Index.) It coagulates from the sap of a particular class of tropical trees, from which it flows out by incisions made for the purpose. See, farther, "On Elastic Fabrics," in Chap. VIII., Book XVII.

2369. *Charcoal* is such portion of the lignin as has escaped complete combustion in burning vegetables, and where the carbonaceous part of it alone remains. In this state it admits of no farther spontaneous alteration, and is perfectly incorruptible. It is used for a great variety of purposes. It is an excellent substance for filtering water; it corrects incipient putrefaction in animal substances, and is extensively used as fuel.

2370. *Wood-ashes.*—When vegetables are completely burned in the open air, all the principles above enumerated are volatilized, with the exception of the potash and soda, which have been already described, and which are separated from the ashes that remain. After these alkalies have been extracted, the remainder consists of a small portion of various earths, and even metals, particularly iron, which entered into the organic structure of the vegetables, but which probably were not always essential constituents. Wood-ashes, from the alkali they contain, are often employed for the same purposes as soap.

2371. *Silica*, or the earth of flints, is a substance which one would not expect to meet with as a necessary ingredient in plants, and yet a whole tribe of vegetables has a varnish of siliceous matter on the outside of their stems; the most remarkable of these is the bamboo; the shining polish of this plant proceeds from a thin coating of pure silex, and small concretions of siliceous matter are often formed in the joints of the stems. The greater number of the grasses, and the various species of corn plants, have an external coating of this substance, which nature has the power of dissolving and converting into a varnish. The existence of this flinty epidermis in the stalks of corn is easily shown by the blowpipe, which fuses it into a minute globule of glass. Silica likewise exists in many plants in minute quantities, but in combination with potash, soda, or lime, and appears on their analysis.

2372. *Besides these, several other elementary substances* are found in vegetables on analysis in minute proportion, as phosphorus, sulphur, lime, iron. All vegetables contain a large proportion of water. Indeed, the

greater accuracy with which organic matter is now analyzed by experienced chemists, compared with what was the case only a few years back, has very much increased the number of substances that enter into the composition of vegetables in very small quantities, and have, no doubt, their effect in the production of their several properties; but to enter into all the details necessary to exhibit this increased complicacy of constitution would render our work unintelligible to the greater number of our readers, and depart from the simplicity which we are desirous of retaining by confining ourselves to what belongs more particularly to domestic economy. Those who are desirous of following up all the discoveries of modern analysts should consult their late publications.

CHAPTER VIII.

DESCRIPTION OF THE VEGETABLES AND FRUITS USED AS FOOD IN THE BRITISH ISLES.

SECT. I.—INTRODUCTION.

2373. One of the principal advantages resulting to Europe from exploring distant regions has been the introduction of numerous useful vegetables and fruits, which are at present cultivated with much success. Whatever horticulture may have been practised in Britain by the Romans, while they had possession of this island, must have been nearly, if not wholly, lost during the disturbed state of several succeeding centuries; and it is indeed remarkable, surrounded as we are with abundance of every kind of useful fruit and vegetable that our climate will admit of, and which many suppose to be natural to the soil, to find that the introduction of by far the greatest number date no farther back than the reign of Henry VIII.

The edible wild plants indigenous in this island are mostly of small growth and harsh taste; and to the skill of the gardener we owe almost all those which at present form valuable articles of diet.

2374. *In this chapter we propose to give a general description* of all the vegetables and fruits used at present as food in the British isles; but the manner of their production or cultivation will be found in works on Gardening and Agriculture.

2375. *In our arrangement we shall adopt the method* followed by Mr. Loudon in his "Encyclopædia of Gardening," to which we are obliged for many useful facts:

1. The Cabbage tribe; 2. Leguminous vegetables; 3. Esculent roots; 4. Spinaceous plants; 5. Alliaceous plants, or the onion tribe; 6. Asparaginous plants, or the asparagus tribe; 7. Acetaceous plants, or salads; 8. Pot-herbs and garnishings; 9. Sweet herbs; 10. Plants used in tarts, confectionery, and domestic medicine; 11. Plants used as preserves and pickles; 12. Edible indigenous plants not cultivated; 13. Poisonous plants; 14. Edible fungi; 15. Edible marine plants.

SECT. II.—CABBAGE TRIBE.

SUBSECT. 1.—*General Account of the Cabbage Tribe.*

2376. The cabbage tribe belongs to the numerous botanical family of the *Cruciferæ*, or, as Professor Burnett has named them, *Brassicaceæ*, some of which are found as weeds in every field; and to one of them, by means of cultivation, we are indebted for all the varieties at present in use.

2377. *The original wild plant*, called *sea-colewort* (*Brassica oleracea*, Linn.), may be seen growing on the cliffs in various parts of the south coast of England, as at Dover and Penzance; and no one unacquainted with the subject would suspect that it had been the parent of so important and numerous a progeny. It is there seen as a plant of scanty leaves, scarcely weighing altogether half an ounce; and, though it may be eaten, it is salt, and n[illegible]ry tender. It is not supposed, however, that all our cabbages, originating from this [illegible]lant, have been the result of English gardening only. This plant is very liable to run into varieties, and some of these have probably been cultivated in other countries from the earliest times.

2378. *The cabbage was known to the Romans*, and was with them a favourite vegetable. Columella informs us that it was produced in sufficient quantity to be used abundantly as an article of food by all classes of people; and as it was a principle with the Romans to carry the arts of civilization into those countries which they conquered, several fruits and culinary vegetables found their way, through this source, into Germany, Gaul, and Britain. Much, also, is probably due to the earliest monastic institutions. It is not accurately known, however, at what time the cabbage was introduced into this island, but it was supposed to have been cultivated here pretty generally in the times of the Saxon heptarchy, the Saxon term for this vegetable being *kale*, a name by which it is still known in Scotland. The close-hearted variety was for many years brought from Holland, and Ben Jonson speaks of this being the case in his time. It is said that cabbages were first introduced into the north of Scotland by the soldiers of Cromwell, though some refer their being planted there to an earlier date: for a long time they were the only garden vegetable in the northern parts of that country. From the abundance, cheapness, and wholesomeness of this plant, it appears to be the most useful of all the culinary vegetables; and so many are the varieties, that one or other is procurable at every season of the year.

2379. *The cabbage tribe putrefy very quickly*, and in decomposing give out a very offensive odour, owing, it is supposed, to their containing a small portion of nitrogen, in addition to the usual constituents of vegetables. Decayed cabbage leaves should therefore never be suffered to lie about in the vicinity of dwellings, and the water in which this vegetable has been boiled should not be retained on the premises, but be passed off into the drains.

2380. *Cabbages are found in general to be wholesome and nutritive*, and to supply a valuable mixture with animal food; but with some constitutions, particularly those who are dyspeptic, they are occasionally indigestible, and productive of flatulency. Dr. Paris is of opinion that they contain an essential oil which is apt to produce bad effects, and he recommends that they should be boiled in two successive waters till they are soft and digestible. But they may be boiled too much, as well as not enough: in the former case, when soft water is used, much of their nutritive properties are extracted, and are lost in the water.

2381. *The varieties of cabbages* are divided into, 1, the various sorts of Borecoles or Kales; 2, the headed Cabbages; 3, the several kinds of Cauliflowers and Broccoli.

SUBSECT. 2.—*Borecoles, or Kales* (*Brassica Oleracea*, Linn. Division 1, *Acephala*).

2382. The character of these is to have the leaves loose, and not formed into a close round head, and their leaves are generally curled or wrinkled. They resemble most the original wild plant. They form an excellent vegetable for the table, and being extremely hardy, are considered by many as the best winter greens, and most to be depended upon. They have been particularly recommended for cottage gardens. In an experiment tried to blanch them, they were found to be much improved. They are not in the least injured by frost. There are several varieties of borecole; one variety well known in London, and in almost every garden in Britain, is the *Scotch kale*, which in Scotland is known by the name of *German kale*, or *curlies*, or curly greens.* Some other varieties are more rare, as *Buda* and *Russian kale*. The former is a low and rather delicate plant, which is excellent for the table when blanched: the sprouts are preferable to the heart. It is from the seeds of a variety of kale that the Colza oil, so much used in France for burning in lamps, is procured by expression.

2383. *The Couve Tronchuda* (*Brassica costata*), or Portuguese cabbage, from Tranxuda, Portugal, is much cultivated on the Continent, and was introduced here in 1821; it is grown chiefly for the midribs of the outward large leaves, which, when divested of their green parts, and well boiled, make a good dish, somewhat resembling sea kale. The heart or middle part of the plant is, however, the best for use; it is peculiarly delicate, tender, and agreeably flavoured, without any of the coarseness which often belongs to the cabbage tribe.

2384. *The palm kale, and the true kale, or Cæsarean cow-cabbage*, are both arborescent varieties of brassica; the first growing to the height of ten or twelve feet, and the latter said even to reach to sixteen feet in La Vendée; their stems are simple, and crowned with tufts of leaves, therefore something resembling the palms in part. The heart of the bud is tender and palatable; the outer leaves are given as fodder to cattle, for which purpose the plant is cultivated extensively in Jersey, and the other Anglo-Norman isles.

2385. *Sea kale*, notwithstanding its name, does not belong to this class of plants, but to the asparagus tribe; its description will be found with them.

SUBSECT. 3.—*Close-headed Cabbages* (*Brassica Oleracea*, Division 2, *Capitata*).

2386. The second division of the brassica consists of those which form their leaves into a round head, as the common white and red cabbage, or into a long head, as the savoys; besides the common white and red, there are several other varieties, as the drum-head, sugar-loaf, &c., and the sub-varieties are brought into use in different seasons, as they are required, some being early, others late.

2387. *The white cabbage is the most common* garden sort. The heads, when well formed, are externally of a yellowish-green colour, and the internal part is very white or blanched; these are from three to twelve, or even fifteen, inches in diameter, and weigh from two to twenty pounds; but the larger varieties are used only for cattle. They are all raised from seeds, are biennials, and are therefore sown the year before it is expected they will have large heads. The first season, while the plants are young, they are often employed as *greens*, under the name of *cabbage plants*, or *cabbage coleworts*; these are pulled up by the roots, and carried to market in that state, which preserves the sap better than when the roots are cut off. Others are transplanted; and when a little farther advanced, when the heads begin to form, they constitute what are called *summer cabbages*. The heads are cut off at various times, according to taste, and the demand for them. In the winter their form is completely round and compact, and they are employed for various purposes, for family use, sea stores, or for cattle. If the ground is wanted, the stalks are pulled up, but sometimes they are left in the ground all the win-

* Some consider another variety, the purple or brown kale, as quite equal, if not superior. The Siberian and the dwarf borecole are also excellent.

ter; and in the next spring fine new shoots proceed from the stems, which are gathered for greens, under the name of *cabbage sprouts*, and which are not inferior to young cabbages. In early cut cabbages these sprouts often form little, tolerably firm heads in the autumn; in the sugar-loaf cabbage particularly, and other forward kinds; these, while young and green, constitute some of the most excellent culinary greens of the season. Gardeners generally suffer a certain number of the strongest cabbage to remain for the purpose of producing sprouts.

2388. *The red cabbage* is of the same general form as the white, but is naturally rather of a purplish colour, mixed with brown, than red. The bluish purple colour, like all vegetable blues, is turned red by any acid; and hence its colour, when employed as a pickle, which is the chief use to which it is applied with us. Its bluish juice is an excellent test for both acids and alkalies; for it turns red with the former, and green by the latter. In Germany they make from this cabbage, as well as from the other varieties, their favourite *sauer kraut*; for the manner of preparing which see Book X., Chap. III., "Pickling." The best kind for pickling is the large red Dutch. The dwarf red, which is more delicate, is principally used for stewing, and is much grown for that purpose on the Continent.

2389. *Savoys* are likewise close-hearted cabbages; but they are distinguished from those already described, by their leaves being very much wrinkled. They are sweeter, and of a more tender texture than the others, particularly the central leaves. They are a winter vegetable, and their season is from November till spring. The dwarf savoy is much improved by frost; and the yellow savoy will bear very severe weather without injury. The green is most tender.

2390. *Brussels Sprouts.*—These are considered as a sub-variety of the last, and are thought by some to be the most agreeable of the cabbage tribe. The stem, particularly in Flanders, is sometimes four feet high; and from the places where the leaves join on sprouts shoot out, which form small green heads, like cabbages in miniature, each being from one to two inches in diameter; the main leaves drop off early. The top of the plant resembles a savoy planted late in the season; it is very delicate in taste, and quite different from the leaves. At Brussels, where they are used as winter greens, they are usually served up at table with a *sauce blanche*, comprised of vinegar, butter, and nutmeg. The tops should be gathered a week or ten days before the sprouts; and the latter, when cooked, should be carefully drained before the sauce is added. The sprouts are best if they have been touched by the frost, resembling in this respect savoys.

2391. *Cauliflower and broccoli* (*Brassica oleracea*, Division *Botrytis*). This division comprehends those which form a head of their stalks and flowers. It was a favourite saying of Dr. Johnson, "Of all the flowers in the garden, I like the cauliflower best." It is, indeed, the most delicate of the brassica tribe.

2392. *It differs from the other varieties* in having its flowers extremely numerous and compact, planted upon a short, thick, succulent stem, and forming a curd-like head that scarcely rises above the leaves. This stem, with the mass of closely-planted flowers, is the part which is cut off and dressed.

2393. *It is not certain at what period the cauliflower was introduced into English horticulture*; but it was cultivated here about the beginning of the seventeenth century, and came to us from the Island of Cyprus. Its cultivation in England has been very successful; and though the Dutch horticulture long excelled the English, yet this vegetable was produced here in greater perfection than in Holland; and, before the French Revolution, used to be exported to that country.

2394. As it requires a richer soil and warmer situation than the other varieties of the brassica tribe, it must always be higher in price; but from the great industry and spirit of our gardeners, it is now become so cheap as to be within the reach of all classes. In 1619, two cauliflowers cost three shillings. The heads of the cauliflowers are not nearly so liable to putrescency after being cut as its leaves, which in this respect are similar to those of the cabbage; and they may be preserved for months through the winter by pulling up the plant entire, picking off the decayed leaves, and hanging them up in a cellar or shed, or by burying them in pits in the ground.

2395. *Broccoli.*—The name is Italian; it is usually considered as a sub-variety of the cauliflower, and is distinguished from it by the head being of a dark green or purplish colour, instead of white, as the latter; though lately gardeners have produced a white broccoli that very much resembles cauliflower in all its valuable qualities. The purple sort, when boiled, becomes green. Broccoli is likewise much hardier, and is made to stand the winter; and it is a great advantage that cauliflower and broccoli bear their heads at different seasons of the year. Both are excellent and wholesome.

Sect. III.—Leguminous Vegetables.

2396. *The legumes*, or, as they are also called, *pulse*, contain the greatest quantity of albumen and gluten next to the grains or seeds of the corn plants, and rank the nearest to them in their nutritive qualities. Except the corn plants (which will be treated of under the article "Bread") and the potato, pulse are the most important of the farina-

ceous esculent vegetables. They consist of the pea, common bean, and kidney bean, lentil, tare, and vetch: the first three only are used as food for man in Britain. Next to fruits and the nut species, perhaps, the pulse tribe were earliest resorted to for nourishment, as it required little labour to prepare it. In their young state, when succulent, several of them form favourite articles on the table; but when they have come to maturity, or are dried, they are less acceptable, requiring strong powers of digestion. It is fortunate, however, that even then they furnish excellent food for various domestic animals; and thus the soil, which would be exhausted by perpetual crops of grain, is enabled to recover its fertility under the less severe production of the various sorts of pulse.

SUBSECT. 1.—*The Common Pea* (*Pisum Sativum*, Linn.).

2397. Of the pea there are many species, but this is the only one cultivated in this country. It has long been known as a culinary vegetable in India, China, and Japan, but is probably not originally a native of a very warm climate. It has no doubt found its way into Britain from the southern parts of Europe, and appears to have been extensively used as one of the staple articles of food in England at a very early period; for it is on record that in 1299, when the English forces were besieging a castle in Lothian, they subsisted upon pease and beans grown in the vicinity, after their provisions were exhausted. The more delicate varieties, however, do not appear to have been known in England until much later, since it was observed by Fuller, in the time of Queen Elizabeth, that pease brought from Holland were "fit dainties for ladies, they came so far, and cost so dear."

2398. *Though culture has produced a great many varieties of pease*, yet they may be all included under two divisions, the white or yellow, and the gray. Of the white, the choicest sorts are raised in gardens, to be eaten green; but vast quantities are likewise cultivated in the fields, and are allowed to ripen to be dried. The gray pease are coarse-flavoured, and are used only as food for horses and cattle.

2399. *The sub-varieties of the common pea are very numerous*, and are continually changing from culture: even the names of them vary, which renders it difficult to determine with respect to the best sorts. Among the principal varieties at present are the *marrow fats*, the *egg*, the *moratto*, the *Prussian blue*, the *rouncival*, &c. Pease form a light, wholesome food when they are green and succulent, and gardeners sow them at various periods, so as to have them fit for gathering in succession. They are generally distinguished into *early* and *late*; the former are often forced on hot beds, and form the grand vegetable luxury at the approach of summer. These, however, are never so rich and saccharine as those which come to maturity by the natural heat of the season; hence green pease are really of the best quality when they are so abundant and cheap that they can be purchased by every one. When the white or yellow sorts are ripened for drying and splitting, they are called *boilers*, as they are mostly used for soup, or pease pudding. Vast quantities of these are consumed in the navy. It is found that, after they have been kept a year, they do not break or fall well in the soup; and this property likewise depends much upon the soil in which they grow. Pease are also ground into flour, which forms a milky solution with water, owing to the presence of an oily matter. Although highly nutritive, ripe pease are much more indigestible than the corns, and the bread they afford is apt to lie heavy on the stomach: it is chiefly confined to the labouring classes, and those who have strong powers of digestion.

2400. When green pease are sent to market in sacks, they are apt to heat, and a fermentation commences in a few hours, by which the pea loses its sweetness and fine flavour; this may be observed constantly in the season in Covent Garden market. Those sent in sieves, or flat, shallow baskets, are not liable to this objection.

2401. *Ripe pease analyzed by Einhoff* gave, in 3000 parts, starch 1265 parts; fibrous matter analogous to starch, with the coats of the pease, 840; mucilage, 249; saccharine matter, 81; albumen, 66; earthy phosphate, 11; volatile matter, 540; loss, 229.

2402. *Sugar Pea.*—This is a variety lately introduced, very sweet, and in which the tough internal film of the pod is wanting. These pods, when young, are boiled whole, and eaten in the manner of French beans.

2403. *The chick pea* is little known in Britain. It is a very small variety, much cultivated in the south of Europe. The seeds do not become soft by boiling; but are sometimes parched in a frying-pan in Egypt and Syria, where they are considered as convenient food for travellers who make long journeys. In Spain, they form an ingredient in the *olla*, a national dish. In Italy, and the south of France, they are sometimes roasted as a substitute for coffee.

Some other small varieties of the pea are known and used in Arabia and India, but they are not of much value, except to the poorest classes.

SUBSECT. 2.—*The Garden Bean* (*Vicia Faba*, Linn.).

2404. *The common or garden bean* has been cultivated in Britain from time immemorial, but is supposed to have been introduced by the Romans, and to have come originally from Asia, whence it spread into Italy, Egypt, and Barbary.

2405. *The seeds* of the large variety of garden bean, called the *Windsor bean*, are preferred for the table. The *Mazagan* is one of the earliest and best flavoured, and the

Green China is late; the seeds of the last remain green when ripe and dried. Other varieties, as the *common horse bean*, the *tick bean*, and the *small Dutch bean*, are cultivated in the fields for fattening domestic animals, for which they are admirably adapted. In some places, meal from beans is mixed with other meal for making coarse bread, and a small quantity of them is generally mixed with new wheat when ground to flour; the millers pretend that soft wheat will not grind well without beans, and they generally contrive that there shall be no deficiency in the necessary proportion. This practice is well known to bakers and dealers. Bean meal mixed with water, and given to cows, increases the quantity of their milk.

2406. *The bean contains much more nutritious matter than most other vegetables.* From the analysis by Sir H. Davy, more than half its weight consists of principles fit for nutriment. Ripe beans contain, according to Einhoff, 84 per cent. of nutritive matter, of which 50 is pure farina, the rest chiefly gluten and mucilage; when young, they are tender and digestible, but when old they become tougher, and prove flatulent to some persons. They are often eaten with bacon or pork by the country people of England, with whom this is a favourite and wholesome dish, the farina of the bean correcting the oily nature of the bacon. The epidermis or skin becomes tough as the beans get old, and, containing a bitter, should be removed.

2407. *The Kidney Bean* (*Phaseolus*, Linn.).—Two species of kidney beans are cultivated in England: the dwarf kidney, usually called the *French bean*; and another, somewhat larger, called the *scarlet runner*, distinguished by the beauty of its flowers, and long cultivated for them before it was used as food. The first (*Phaseolus vulgaris*) is a native of India; and the second (*Phaseolus multiflorus*) was brought from South America in 1633, being first cultivated by Tradescant, the celebrated gardener, at Lambeth; it is the hardiest of the two. In England, the unripe pods of both, but particularly the French bean, are cooked whole in the green or unripe state. In France, where both kinds of kidney beans are cultivated extensively in the fields, the seeds are suffered to ripen, and, under the name of *haricot blancs*, form part of a great variety of dishes, and are much esteemed as very nutritious food; but the green pods used by us are not so. The scarlet runners are also with us dressed in the pods, and have the advantage of being procurable for a longer time than the French bean. They are also the sort most esteemed in France for haricots, their seeds being more farinaceous than the dwarf. (See "*Le bon Jardinier*," 1835, p. 242.) The French bean is wholesome and nutritious in a fresh state, rarely disagreeing with any one for whom vegetables are proper, and may be readily preserved for winter use or sea voyages by salting in casks. For this purpose the large-podded Dutch white runner is preferred. See Book X., "Preservation of Food."

2408. *Lentils* are not used as the food of man in England, though they are on the Continent, where they are cultivated for soups and other culinary preparations; but they are of a larger kind than ours, which are considered as the best food for pigeons.

Sect. IV.—Esculent Roots.

2409. *The roots of many plants supply food, and hence are called esculent.* Those cultivated in Britain may be divided into two groups: the *farinaceous*, as the potato and the Jerusalem artichoke, to which may be added the yam; and the *succulent*, as the turnip, carrot, parsnip, beet, radish, and a few more of less importance. This class of culinary vegetables is that on which the British people chiefly depend; and it is that which is decidedly the best suited to the climate. The potatoes and other esculent roots grown in the British islands are very far superior to those of the Continent in quality, and the quantity consumed is much more considerable.

Subsect. 1.—*The Potato* (*Solanum Tuberosum*).

2410. *The potato, a well-known tuber, popularly, though not with botanical correctness, considered as a root,* may be ranked next in importance to corn as a vegetable food. There is no doubt that it was originally brought to Europe from South America; but its early history has been involved in some obscurity, partly from their being another root very similar, the sweet potato (*Convolvulus batata*), with which it had been confounded, and from which it appears to have received its name.

2411. *The batata* was originally a Malayan plant, and was imported into England from Spain and the Canaries long before the introduction of the potato. It was esteemed a great delicacy, and made into a confection, and is still partially cultivated in Spain and the south of France. It was this that was alluded to by Shakspeare in his Merry Wives of Windsor, "Let the skye rain potatoes, and hail kissing-comfits."

2412. *The true potato is said to have been first brought into this country* from Virginia by Hackluyt in 1584, and planted by Sir Walter Raleigh on his estate at Goughall, near Cork, in Ireland, where it was cultivated to a considerable extent before its value was known in England. Gerarde, in his Herbal (1597), mentions it as "a delicate dish;" and Parkinson, in 1629, says that they were roasted, and then steeped in sack and sugar, or baked with marrow and spices. For many years afterward they were con-

sidered as inferior to the Jerusalem artichoke; and, indeed, it was not till the middle of the eighteenth century that they came into general cultivation. Even so lately as the beginning of the nineteenth century, a strong prejudice against potatoes existed in France, though now they are cultivated there to a great extent, and a market in Paris is exclusively devoted to their sale.

2413. *The question as to what is the indigenous country of the potato is now set at rest*, by its being found abundantly in the wild state in the highlands of Chili and Peru, from whence tubers were sent by Mr. Caldcleugh in 1828, and planted in the garden of the Horticultural Society. Potatoes in their wild state in America are of a very small size, and by no means of an agreeable taste. The varieties which we now find in the markets are entirely the result of cultivation.

2414. *The potato has now been introduced into almost every quarter of the globe*, and its cultivation has made the most rapid progress of late. It is the more valuable, as it grows readily in almost every climate, and its culture is extremely easy; it has also this grand advantage, that it will succeed on land which will not produce grain, and may be raised at a small expense. A given quantity of land planted with potatoes will produce as much food as twice that quantity sown with wheat.

2415. *It forms a wholesome food*, and, having no great peculiarity of taste, is relished by every palate; hence it is now a regular standing dish at every table; with many, particularly in Ireland, it serves as a substitute for bread.

The most correct opinion respecting the nutritive properties of potatoes will be obtained from the consideration of their constituent principles. They have been analyzed by various chemists: the analysis by Einhoff, which is generally received as the best, is, in 100 parts, water, 72·6; starch, 15·0; fibrous matter, 7·0; albumen, 1·4; mucilage, 4·0. Here it is essential to observe the large proportion of water, and it is only the remainder that is to be considered as farinaceous. Tartaric acid is abundant in the potato apple; and it is important to notice that the young shoots of the potato yield *Solanea*, an alkali which is, to a certain degree, poisonous.

The fibrous part appears to be a peculiar modification of starch, which, as well as that substance, may be employed for food; but it is to be noticed that there is no gluten, except the albumen may be considered as nearly the same thing. Various kinds of potatoes afford these constituents in proportions a little different; but the above may be considered as the average of the best mealy potatoes, the nutritive part being about twenty-seven per cent., of which the starch is the principal portion. No doubt can be entertained of their wholesome nature, when we consider the numerous hardy peasantry of Ireland, many of whom subsist entirely upon this useful vegetable. It must not, however, be imagined that potatoes contain the same nutritive powers as bread, weight for weight. It has been estimated, as the result of experiments, by two French chemists, MM. Percy and Vauquelin, that one pound of good bread is equal to two pounds and a half or three pounds of potatoes; that seventy-five pounds of bread and thirty of meat are equal to three hundred pounds of potatoes.

2416. *A considerable deduction must be made from the advantages of potatoes*, on account of their requiring much manure for their cultivation, together with the difficulty of transporting and preserving them in consequence of their bulkiness. The time occupied by labouring people in cooking them in the usual way is also a drawback from their usefulness. From their want of gluten, they cannot be fermented alone into bread, but they are advantageously mixed with wheat flour for this purpose.

2417. *London is well supplied with potatoes* from various parts of the country; and the varieties are so numerous, that almost every town has some sort peculiar to its vicinity, the names varying in different districts. They are distinguished as being *farinaceous* or *mealy*; *glutinous* or *watery*; or, according to the ripening, *early* and *late*. Those varieties that are mealy are most esteemed, afford the most nutriment, and are most easily digested; the waxy kinds are inferior in all these particulars. New potatoes are less mealy and less digestible than old ones.

2418. *The earliest potatoes* are cultivated by the gardeners: of the field potatoes, among the most remarkable early sorts are the *early kidney*, *nonsuch*, *early Shaw*, and *early champion*, which last is more generally grown near London. Among the best sorts of late potatoes are the *red round kidneys*, the *large kidney*, the *bread fruit*, &c. The most mealy sorts are the most nutritive, as containing the greatest quantity of starch, and they are likewise the most digestible. The kinds called waxy are said to be very improper for dyspeptic persons.

2419. *In England potatoes are most frequently brought to table boiled plain*; but in *France* they are cooked in a great variety of ways, and furnish many very agreeable dishes.

The boiling of potatoes in the best manner, which to some may appear an operation of no difficulty, requires considerable attention; and much of the goodness of this vegetable depends upon its being properly cooked. The Irish have long had the reputation of being particularly successful in this part of the culinary art. The directions given in the Farmers' Magazine, vol. v., p. 191 and 503, are as follows: "It is of consequence that they be as nearly as possible of one size; that they be well washed and cleared of earth or dirt; that they be put, with cold water, into a pan or kettle, well rinsed about, and kept there for an hour or two, which will extract the black liquor with which they are impregnated. They ought then to be put, with their skins on,

not into boiling water, like greens, but into fresh cold water, with a little salt, and boiled in a kettle or saucepan, closely covered, in the most rapid manner. No more water should be put in than merely to cover them, as they produce themselves a considerable quantity of fluid. When sufficiently done, the water should be instantly poured off, and the vessel containing the cooked potatoes is to be placed on the side of the fire, with the cover off, until the steam be completely evaporated; the potatoes are thus rendered quite dry and mealy." There is some difference among cooks in England in the mode of boiling them. Some pare them when raw, like turnips; but this renders them tasteless and insipid; and some think they should be boiled slowly, and for this reason throw in occasionally a little cold water to check the boiling when too fast, which is apt to crack the outside, and let in the water before the heart is done.

2420. *Cooking them by steam* is a good method, as, should they break, to which they are very liable, they cannot imbibe such a quantity of water, and are therefore more easily obtained in the floury state, which is generally preferred.

2421. *Roasting* is another very excellent mode; and Dr. Paris considers it as the best way of preparing them for invalids. Sometimes they are parboiled, and then roasted. *Baking* is not so good a mode of cooking them. They are perhaps the only root grown in Britain which may be eaten every day without satiating the palate.

2422. *Potatoes in their raw state* contain an acrid matter, which is deleterious in some degree even to cattle.

2423. *Potatoes are employed in some other ways*, as largely in the manufacture of bread; see Book IX., "On Bread;" also for starch, see Book XXII., "Laundry."

2424. *Potato flour is, in fact, dry starch powder* procured from the potato, and is much used in Paris in fine bread and pastry: it is also sold in the shops here, but often as arrow-root, to which it is inferior. It is said that several other articles found in our shops are only potato starch, as *Bright's nutritious farina*, *Indian corn starch*, &c.; these are sufficiently wholesome and light, but not very nutritive. Potato starch is easily convertible into sugar; but this is much inferior in sweetness to that of the sugar-cane. It is clammy, and has something of a floury appearance; but, being very white, it is said to be employed by the grocers for adulterating. It is also used for distilling ardent spirits, and for the making of beer. The refuse of the potatoes, after the starch has been extracted, has been found useful in scouring woollen cloths without hurting their colour; and the water decanted from potato starch is excellent for cleaning silks with the smallest injury to the colour.

For the effects of frost on potatoes, see Book X., "On the Preservation of Food."

Potatoes have been found to be an excellent preventive of scurvy, cooked in the ordinary way, or baked under ashes.

2425. *The sweet potato* (*Convolvulus batata*) is a tuberose root common in tropical countries, but of quite a different species from the common potato. It forms a sweet, nourishing food used as potatoes. This plant had been introduced into England by Sir Francis Drake and Sir John Hawkins before the common potato; but, though it is cultivated in other parts of Europe, our climate was found to be too cold for its growth in the open air.

Subsect. 2.—*Jerusalem Artichoke* (*Helianthus Tuberosus*, Linn.).

2426. *Notwithstanding the name, this plant is no way allied to the artichoke*, but is of the same genus as the sunflower, and much resembles it. The term Jerusalem is a corruption of girasole, the Italian name for sunflower; and it derives the appellation of artichoke from some agreement of its taste with that of artichoke bottoms. The root, which is the part that is eaten, consists of a cluster of tubers in shape somewhat like the potato; and there are often thirty or forty together. It is a native of Brazil, having been brought to England in 1617; and, before potatoes were so generally adopted, was much in use. It was at first called the Canada potato, to distinguish it from the common potato, which was called the Virginian potato, to which it was at first greatly preferred. It is wholesome and of an agreeable taste, though it is never dry and mealy like the potato, but rather moist and soft in its texture; and, when they do not disagree, they are nutritious. They are extremely productive, and succeed in almost every soil: when once planted, being a hardy perennial, they will continue to flourish without requiring much manure or attention. They likewise form a nutritive food for horses, hogs, &c., containing much farinaceous matter.

Subsect. 3.—*Yam* (*Dioscorea Sativa*, Linn.).

2427. *This tuberose root is extensively cultivated in the West Indies, Africa, America*, and *the East Indies*, where it is eaten, roasted or boiled, as a substitute for bread. Its taste nearly resembles that of the potato, but it is rather sweeter, and of a firmer texture. The root is flat, and often palmated or divided somewhat like fingers, and about a foot across; a variety called the *winged yam* is three feet long, and weighs thirty pounds. It is a native of India, where it grows in the woods, and was carried to the West Indies. It is sometimes imported into this country, but rather as an article of curiosity. When fresh, it contains an acrid juice, which causes itching if applied to the skin; but, by heat, this acrid principle is wholly dissipated; and, as it contains a great deal of farinaceous matter, it forms a light, nutritious, and palatable food, either boiled or roasted. Yams are also made into puddings. In Otaheite, a favourite dish is made of them with scraped cocoanut and the pulpy fruit of the banana.

Subsect. 4.—*Turnip* (*Brassica Rapa*, Linn.).

2428. *Turnips grow wild in England*, but these cannot by cultivation be brought to re-

semble exactly the cultivated vegetable. It is said that they were brought here from Hanover. Turnips contain mucilage, little or no gluten, but a good deal of sugar, though the quantity of the latter varies exceedingly, and is not so considerable as in the carrot. The quantity of nutritious matter, upon the whole, in turnips is small; according to Sir H. Davy, only 42 parts in 1000. They are an excellent culinary vegetable, much used all over Europe, and are either eaten alone, mashed, or cooked in soups and stews. A hot climate does not seem to agree with them; and in India they and many of our garden vegetables lose their flavour, and are comparatively tasteless. The Swedish is the largest variety, but too coarse for the table; it is excellent for cattle. The green leaves of the turnip, gathered young in the spring, make good greens, well known by the name of *turnip tops*. The leaves for greens are good from any of the varieties, but are less acrid from the Swedish. Turnips grown in the field will be found of a better flavour than those produced in the garden; and the same remark applies to all the brassica tribe, with the exception of the cauliflower and broccoli, as also to potatoes and tuberous roots.

2429. *The French navet* is a variety of turnip (*Brassica napus esculenta*), but has more the shape of the carrot. It is of a very fine flavour, and is much esteemed on the Continent for soups and made dishes. Two or three of them will give as much flavour as a dozen common turnips; stewed in gravy, it forms an excellent dish. The peculiar flavour resides in the rind; consequently, this is not cut off, but only scraped. The *navet* was once grown here; at present it is seldom to be found in our gardens, though very deserving of being cultivated. It is of a yellowish-white colour, and resembles the carrot in form. It is often, on the Continent, served up with them as ornamental, on account of the contrast of colour. It is sometimes imported to the London market.

SUBSECT. 5.—*Carrot* (*Daucus Carota*, Linn.).

2430. *A wild carrot* grows in England in sandy soils, but it is small, white, and stringy, and of a strong flavour. Our garden carrot was introduced by the Flemish refugees who settled at Sandwich in the reign of Queen Elizabeth. This plant was so esteemed that the ladies wore the leaves as ornaments in their headdresses. At present a pretty winter ornament is made from the carrot, by placing a slice from the top of the root in a shallow vessel of water, when the young and delicate leaves shoot out, and form an elegant radiated tuft.

2431. *The carrot contains a larger proportion of sugar than any of the corn plants*: in 1000 parts they have 95 parts of sugar, and 3 of starch; this is about six times as much as is found in potatoes; hence a large quantity of spirit can be distilled from them, about half a pint from ten pounds, and they may be used instead of malt for beer. Attempts have been made to obtain the sugar in a crystallized state, but without success.

2432. *Their value in the culinary art is well known*; they are extremely useful in soups and stews. When eaten alone, they should be well boiled, and not too old, as they contain a large proportion of fibrous matter which does not digest very easily. Cattle are extremely fond of them, and they form an excellent fattening food.

2433. *M. Vilmorin of Paris has lately introduced two good varieties* of the carrot, the short yellow and the violet. The latter, which he obtained from Spain, grows to a large size, and is remarkably sweet. The carrot is cultivated by some farmers in their gardens for the purpose of colouring butter; but this is the large red variety, or field carrot. The orange carrot is the kind usually cultivated as a garden vegetable, and is of a more delicate flavour.

2434. *When a carrot is cut across*, it will be seen to consist of two parts, the outer one reddish, and the inner more yellow; the first answers to the bark of wood, and is the most pulpy and sweetest; the latter is the wood itself, and is more stringy. The greater the proportion of this external part in any variety, the more valuable it will be. The carrot may be kept in a succulent and fresh state for a long time, nothing more being necessary than to bury it in sand, and protect it from the frost.

SUBSECT. 6.—*Parsnip* (*Pastinaca Sativa*, Linn.).

2435. This also is a native British plant, being often found growing by the road-side; but it has not altered so much as the carrot. It is generally used with salt fish in Lent.

2436. *It contains still more sugar than the carrot*, and some persons dislike it on account of its peculiar sweet taste. Besides its use at the table, a pleasant beverage can be brewed from it with hops, as is practiced in the north of Ireland: it will also furnish an ardent spirit and wine. In Scotland, parsnips and potatoes are beat up with butter into a dish for children, who are remarkably fond of it. They are excellent fried.

2437. *The Guernsey parsnip* appears to be an improved variety: it grows there to the length of four feet, and three or four inches in diameter. When parsnips are grown in a poor soil, they lose much of the rank taste which they acquire in richer ground; and when they are roasted, as they are in the north on peat ashes, they become sweet and agreeable, and almost as farinaceous as potatoes.

SUBSECT. 7.—*Beet Root.*

2438. *There are two varieties of the beet commonly cultivated*; one having a large fleshy

root (*B. vulgaris*, Linn.), and the other producing large succulent leaves (*B. cicla*), which we arrange among the spinaceous plants.

2439. *The common beet root* is of a fine red colour, and is originally a native of the sea-coast of the south of Europe, growing wild all along the coast of the Mediterranean. It was brought into this country, in 1656, by Tradescant. It is chiefly employed in England as a garnish for salads and other dishes, on account of the beauty of its colour, and it is also used as pickle. On the Continent it is sometimes boiled sliced, and eaten cold with oil and vinegar; when warm, boiled or baked, its taste is mawkish, and it is said to be not very wholesome if eaten in any quantity.

2440. A variety of beet root called *mangel wurzel* is a coarser kind, grows to a very large size, and is cultivated in the fields for cattle. An improved and smaller variety, which has a red skin, and when cut through is white or veined with white, is extensively employed in France for the manufacture of sugar. See "Sugar," Chap. XIII., Book VII.

From their containing so much saccharine matter, they may be made available for the production of beer or of spirits instead of malt. The French greatly esteem a sort called *castelnandin*, which is said to have the flavour of a nut.

Subsect. 8.—*Radish* (*Raphanus Sativus*, Linn.).

2441. The radish is supposed to be a native of China, but has long been cultivated here. They contain little else than water, woody fibre, and acrid matter, which resides in the external part; they cannot, therefore, be very nutritive, but they may prove a useful stimulant. There are various kinds, but they are generally divided into the turnip and spindle-rooted radish. Many are forced for the early market, and the young seedling leaves are sometimes used for small salad. The seed pods, when green, used to be pickled as a substitute for capers, and formerly the leaves were boiled as pot-herbs. The colour of radishes varies extremely; passing from white to red, and through every shade of that to a dark purple, approaching to black. Professor Burnet states that the roots when boiled and served with toast and butter, and seasoned with pepper, have much the taste of sea kale or asparagus, and form a very palatable dish.

Subsect. 9.—*Skirret* (*Sium Sisarum*, Linn.).

2442. This root is composed of several tap roots, the size of the little finger; and, though now little used, was formerly much esteemed boiled and served up with butter. Worlidge, in 1682, speaks of them as the "sweetest, whitest, and most pleasant of roots." It is a native of China.

Sect. V.—Spinaceous Plants.

The name of this tribe is derived from spinach, the principle plant among them.

Subsect. 1.—*Spinach* (*Spinacia Oleracea*, Linn.).

2443. *A wild spinach grows in England*, somewhat different from the garden variety, but cultivated in Lincolnshire in preference. The leaves are used as spinach, and the young shoots as asparagus. Spinach is known to have grown here at an early period; and in the monasteries on the Continent it was employed, in 1351, as we do at present.

2444. *The leaves of the garden spinach* are softer and more succulent than any of the brassica tribe. There are three principal varieties; one, the *common spinach*, having the leaves round; *another*, having long triangular leaves; the third is called *Flander's spinach*, and has remarkably large leaves; the round-leaved is procured in the spring, and the long-leaved in the winter. Spinach forms a useful ingredient in soups, and the leaves are also boiled alone and mashed as greens.

2445. *Orache*, or *mountain spinach*, is a hardy sort, much esteemed in France, that produces abundance of large leaves, and forms an excellent summer vegetable. It is a native of Tartary, introduced in 1548. There are two varieties, the white and the red: the young and tender stalks are eaten as well as the leaves.

2446. *New-Zealand spinach* (*Tetragonia expansa*) was discovered in New-Zealand by Sir Joseph Banks, who brought it to England. It is found to grow here perfectly well in the open air, and its leaves are larger and more juicy than the common spinach. It produces fine succulent leaves in the hottest weather in great luxuriance, and has the advantage of being in season when the common spinach is not.

2447. *Chenopodium Quinoa*. This variety is not only useful in its leaves for spinach, but the seeds of the yellow variety are excellent when used as millet, and it bears them abundantly.

Subsect. 2.—*White Beet* (*Beta Cicla*, Linn.).

2448. *This variety of beet is distinguished by its large succulent leaves*, which alone are eaten, and not the root, which is small. It is cultivated in gardens as a culinary vegetable, and is boiled as spinach, or put into soups. It is less known here than on the Continent, where, in many parts of Germany, France, and Switzerland, it forms one of the principal vegetables used by agricultural labourers and small occupiers of land.

2449. A large variety, known by the name of *Swiss chard*, produces numerous large

succulent leaves, which have a solid rib running along the middle. The leafy part being stripped off and boiled, is used as a substitute for greens and spinach, and the ribs and stalks are dressed like asparagus or scorzenera, or sliced and stewed; they have a sweetish taste like sea kale, and are more wholesome than the cabbage tribe; but some consider them as having an earthy taste, and, upon the whole, they are not much esteemed. Cattle are very fond of the leaves, which occasion them to give much milk without affecting its taste like turnips or cabbages.

SUBSECT. 3.—*Sorrel* (*Rumex Acetosa*, Linn.).

2450. *Sorrel is much used in French*, and but little in English cookery. It grows wild in our meadows, but is sometimes cultivated in the garden. The leaves are remarkable for their acidity, and are much employed on the Continent in soups, sauces, and salads; but the French sorrel is different from ours, being round-leaved, and very superior in flavour to our common garden sorrel.

2451. *The acid juice contained in the common sorrel* just mentioned, and likewise in another variety called wood sorrel (*Oxalis acetocella*), is what chemists term an oxalate of potash, or, more strictly, a binoxalate of potash; that is, it consists of potash combined with the oxalic acid. This salt, existing ready formed in the plant, though in a state of solution in the juice, may be procured in a dry state by evaporation; and it is then popularly named *salt of sorrel*. Large quantities of it are prepared from wood sorrel in Switzerland and other neighbouring countries; sixty or seventy pounds of leaves yield about five ounces of the crystallized salt. With sugar and water the salt of sorrel forms a pleasant beverage; and in consequence of its having been substituted for lemons for purposes of this kind, it has obtained the very absurd name of *essential salt of lemons*, though having nothing to do with the lemon. But it is proper to state that one of the component parts of this salt, namely, the oxalic acid, is a deadly poison; and that, although the oxalate of potash is not so dangerous, it is by no means safe to use it in any quantity, and therefore very improper to employ it in any way in drink, though it has been ignorantly recommended to make a refreshing beverage in febrile diseases, or as imparting flavour to punch. If the result has not proved fatal, is has probably been because the quantity taken was small.

2452. *The most useful property possessed by the salt of sorrel* is that of taking out spots of ink or iron moulds from linen: it is also used by the cook in flavouring, instead of the leaves.

The process by which the salt of sorrel is obtained is very simple. The expressed juice of the leaves, being diluted with water, is suffered to remain at rest for a few days until the feculent parts have subsided; or, if greater despatch be necessary, it is clarified with the whites of eggs. When the liquor is sufficiently clear, it is drawn off and evaporated by boiling, until a pellicle appears on the surface. It is then set in a cool place to crystallize. When the first crop of crystals has been obtained, the liquor which remains is again evaporated and crystallized; and so the process continues until no more of the salt can be separated.

In the late Professor Burnett's Botany it is stated that, since Scheele discovered that oxalic acid may be formed by acting on sugar with nitric acid, his process, being far the most economical, has in general superseded its extraction from the plant.

SUBSECT. 4.—*Patience Dock* (*Rumex Patientia*, Linn.).

2453. This is called by the Germans winter spinach, and is a hardy perennial plant; the leaves of which may be cut several times in a season. It was formerly much used mixed with sorrel, but is now neglected.

SECT. VI.—ALLIACEOUS PLANTS.

2454. *This tribe*, which takes its name from *allium*, the onion, is distinguished by their bulbous roots, and the high pungent flavour of their bulbs and leaves. They consist of the onion, leek, chive, garlic, and shallot. These plants are, perhaps, more generally diffused all over the world as an article of food than any other; and, from the Indus to the northern tribes of Asia, they were always held in high estimation.

SUBSECT. 1.—*Onion* (*Allium Cepa*, Linn.).

2455. The onion was cultivated in very remote times, having been known to the ancient Egyptians, who worshipped it under some mystic signification 2000 years before the Christian era. It forms a favourite food in Egypt, and in various other parts of Africa, where it is distinguished by its delicate flavour. It is not known when onions were first introduced into England, but they have been long used, and esteemed chiefly as a seasoning for various dishes.

2456. The onion contains much nutritive mucilage. It is much more succulent, and of a milder flavour in warm climates than with us. Those imported from Spain and Portugal are large and mild, and those from Strasburgh are much esteemed. These varieties, when planted in England, degenerate, and become smaller and more pungent. Onions are wholesome employed in any way; they are eaten raw by labouring people, and in this state are strongly stimulant. When young they are sometimes introduced into salads. The large mild kinds, called Spanish onions, are often boiled or roasted, and are considered as an agreeable and nutritive food. They become much more succulent, and their peculiar smell and taste are nearly destroyed, after having undergone

culinary preparation. They form one of the most essential productions of the kitchen garden; but the odour which they communicate to the breath is a great objection to their use in the raw state: the best way of removing it is by chewing a little raw parsley.

2457. *The potato onion* is a curious variety, multiplying by numerous bulbs, like the potato.

2458. *The Ciboule*, or *Welsh onion*, never forms any bulb at bottom, and is only cultivated to be drawn as young green onions for salad in the spring: its taste is, however, stronger than the garden onion. It is very hardy, surviving the severest winter, in which, though their blades be cut off, the roots remain sound, and shoot out vigorously in the spring.

2459. *The onion has been analyzed* by Fourcroy and Vauquelin, and found to contain water, sulphur, phosphoric and acetic acids, some vegeto-animal matter, and a little manna; to the latter is owing the sweetish taste observable in onions, particularly in pickled onions, when the acrimony has been extracted by the vinegar.

Subsect. 2.—*Leek* (*Allium Porrum*, Linn.).

2460. The leek is supposed to be a native of Switzerland. Shakspeare, in Henry V., mentions it as the badge of the Welsh before his time, and derives the origin of this from the battle of Cressy. Its hardiness and pungency have recommended it in cold mountainous districts, and it was an ingredient in two very old Scotch dishes, "Cock a leekie," a great favourite with James I.; and in the famed "Haggies." The leeks which are cultivated in the colder parts of the Highlands of Scotland, and in Wales, are more pungent than those of England. Worlidge observes of Wales, "I have seen the greater part of a garden there stored with leeks, and part of the remainder with onions and garlic." Tradition says it was introduced into that country by St. David.

2461. Many prefer its flavour to that of the onion in broth; and, as it stands the winter, it is a very useful pot-herb. Leek porridge is a very ancient dish. The whole plant is used in soups and stews, but the blanched stem is most esteemed; these are very good boiled, and served up on toasted bread and white sauce. Notwithstanding its unpleasant odour, it is very wholesome, but requires to be well boiled, that it may not taint the breath.

Subsect. 3.—*Chive* (*Allium Schœnoprasum*, Linn.).

2462. This is the smallest of the onion kind, rising but a few inches high: it is a native of Britain, and is found occasionally in our pastures. Its taste much resembles that of the onion, but is milder. The bulbs are extremely small, and in clusters. Both these and the leaves are employed as a pot-herb, and as they are very hardy and easily cultivated, they would be very useful in the garden of the cottager, were he accustomed to live more upon broths. The leaves rise early in the spring, and are sometimes employed in spring salads, and also in omelets and soups.

Subsect. 4.—*Garlic* (*Alium Sativum*, Linn.).

2463. This gives its name to the alliaceous tribe; it possesses the most acrimonious taste of the whole, and a smell that is considered by most persons offensive. It grows naturally in Sicily, the South of France, and other countries bordering on the Mediterranean; it was introduced into England in 1548. It is extensively used as a seasoning herb on the Continent, particularly in Italy, and was more relished by our ancestors than in our times. The root, which is the part made use of, consists of a group of several bulbs called *cloves of garlic*, enclosed in a common membranous skin. In foreign cookery it is seldom employed in substance, but introduced for a short time only into the dish that is cooking, and withdrawn when it has communicated a sufficient flavour. At present the French use it much, and consider it essential to many dishes.

Subsect. 5.—*Shallot* (*Allium Ascalonicum*, Linn.).

2464. This was originally found growing wild near Ascalon in Palestine, whence its botanical appellation, and is supposed to have been brought to England by the Crusaders. It is a bulbous root, resembling the garlic in being divided into several cloves enclosed in a skin. The leaves wither in July, when the roots are full-grown: the latter are taken up in autumn, and are dried and housed for use: they will keep till the spring. Its flavour is more pungent than that of the garlic, but more agreeable. It is employed in soups and made dishes, also in sauces and pickles; and it forms a favourite accompaniment to steaks and chops. It was called by old authors the *barren onion*, from the circumstance of its scarcely ever sending up a flower stalk.

Subsect. 6.—*Rosambole* (*Allium Scorodoprasum*, Linn.).

2465. This bulbous root has a flavour between that of the shallot and garlic, and, like them, is divided into cloves: its uses are also similar. It is a native of Denmark, but is cultivated here occasionally.

Sect. VII.—Asparaginous Plants.

2466. *The name of this division is derived* from the practice of the ancients, who called

all young sprouts of vegetables by the term asparagus, although this name is now confined to a particular species. This class comprehends *asparagus*, *sea kale*, *artichoke*, *cardoon*, *rampion*, and *alisander*. In all of them it is only a small portion of the vegetable that is eaten, and that most generally in a young and undeveloped state; they belong to the class of luxuries rather than of necessary food, and they are brought to perfection only by great care and attention on the part of the gardener, and at a considerable expense in preparing the ground. In their wild state they are chiefly seashore plants unfit for human food.

SUBSECT. 1.—*Asparagus* (*Asparagus Officinalis*, Linn.).

2467. *Asparagus*, often, in London, vulgarly and absurdly called *sparrow grass*, is a vegetable highly esteemed and largely cultivated in the garden for the London market. It has been so much improved by cultivation that the original plant from which it has been derived could not be recognised except by the botanist.

2468. Wild asparagus is a very small vegetable that grows in poor sandy soils both in North and South Britain, on the seashore, but is not very common. In the saline and sandy steppes of Russia and Poland it is abundant, and is fed on by horses and cattle. The Romans had asparagus of very large size, and it was cultivated with great success in Holland, but it is now grown in greater quantities in the environs of London than anywhere else in the world; at Deptford and Mortlake there are hundreds of acres planted with this vegetable.

2469. The part which is eaten is the young shoot, as far as the flower not yet developed. Asparagus is a light, digestible food, but not particularly nutritious. The tops of the shoots are not blanched in this country, but in Spain the whole is blanched by placing pieces of cane over it.

SUBSECT. 2.—*Sea-kale* (*Crambe Maritima*, Linn.).

2470. *This plant is so named* from its growing naturally *on our seashores*, particularly in the West of England, and near Dublin. The young spring shoots just as they begin to appear, and the stalks of the unfolded leaves, then blanched and tender, are the parts that are cut off and boiled for use. Though collected by the peasants, and eaten as a pot-herb time out of mind, and even cultivated in the garden, yet it appears that it was Dr. Letsom, in 1767, who first gave it a good character, and that it did not come into high repute until 1794. It is now in very general use, and, within the last ten or fifteen years, has become a very common and cheap vegetable. It is one of the most valuable esculents indigenous to Britain.

2471. *It is dressed and eaten in the manner of asparagus*, and the shoots are usually blanched; but it requires to be very well boiled, as it is naturally hard. It is easily cultivated, and forced in the winter season; and it is a great luxury at table, since in that season many vegetables are difficult to be procured. It might be produced in many places on the seashore, where no other edible vegetable would grow, seeming to prefer a poor sandy soil. The flowers form a favourite resort for bees.

SUBSECT. 3.—*Artichoke* (*Cynara Scolymus*, Linn.).

2472. *Like the sea kale, the artichoke is a maritime plant*, and succeeds best when manured with sea-weeds. It was probably brought from the Mediterranean and cultivated in England about 1580. The part which is eaten is the flower head in an immature state; what is called the *artichoke bottom* is the fleshy receptacle, which is surrounded by the bristles and seed down, vulgarly called the *choke*, and by also a soft substance on the lower part of the leaves of the calyx. In England artichokes are boiled plain and eaten with melted butter and pepper; the bottoms are also stewed in milk; occasionally they are pickled. The French fry them and use them in ragouts; or thin slices of the bottoms are cut off, each having a leaf attached, by which it is lifted and eaten raw, as salad. The flowers may be used for coagulating milk. The shoots and young leaves are sometimes blanched by earthing, and eaten as chard. Artichokes may be dried and preserved for use.

SUBSECT. 4.—*Cardoon* (*Cynara Cardunculus*, Linn.).

2473. This plant is a native of Candia, and was brought into England a century after the artichoke. It much resembles the artichoke, but grows higher. It is esteemed on the Continent, but is little used in England; the stalks and ribs of the inner leaves are employed in soups and ragouts. The Spanish cardoon is the best.

SUBSECT. 5.—*Rampion* (*Campanula Rapunculus*, Linn.).

2474. This is a native of England, but not common. The root, which is the part that is eaten, is long, white, and spindle-shaped; it is eaten raw like a radish, and has a pleasant nutty flavour; both it and the leaves are sometimes used in winter salad.

SUBSECT. 6.—*Prussian Asparagus* (*Ornithogalum Pyrenaicum*).

2475. A plant is sold under this name in Bath, and the south and west of England, as a substitute for asparagus. The part which is eaten are the flower stalks before the

buds are expanded. They are served up in the same way as asparagus, and are tolerably good, but rather insipid.

2476. *Hop Tops.*—The young shoots of the hop, when they have risen two or three inches, are also employed sometimes as a substitute for asparagus. In Belgium they are blanched; and they are very strongly recommended as an admirable ingredient in a variety of dishes, such as soups, omelets, &c., by an experienced cook from Sardinia, who mentions them in the "Gardener's Magazine."

SUBSECT. 7.—*Alisander* (*Smyrnium Olusatrum*, Linn.).

2477. This plant also grows naturally near the sea, and somewhat resembles celery in taste. The leaves are of a pale green; when blanched, the leaf stalks were formerly much used as a pot-herb and in salad, but it is nearly out of use.

SUBSECT. 8.—*Bladder Campion* (*Silene Inflata*).

2478. The young shoots of this, when boiled, are an agreeable flavoured vegetable, and are boiled like asparagus.

SECT. VIII.—ACETARIOUS VEGETABLES.

2479. *By the term acetaria*, or *acetarious vegetables, is expressed* a numerous class of plants of various culture and habits, which are chiefly employed as *salads*, *pickles*, and other *condiments*. They are to be considered rather as articles of comparative luxury than as ordinary food, and are more desirable for their coolness or their agreeable flavour than for their nutritive powers.

2480. *Salads consist* of raw vegetables, of which lettuce is the most generally used with us; but several others are occasionally employed, as celery, cresses, onions, beetroot, &c. As raw vegetables are liable to ferment in the stomach, and as they give but little stimulus to that organ, they are generally dressed with some condiments, as vinegar, pepper, mustard, salt, and oil. Considerable difference of opinion exists among medical men respecting the use of these, and particularly oil, some condemning, others approving it.

SUBSECT. 1.—*Lettuce* (*Lactuca Sativa*, Linn.).

2481. *The botanical name of the lettuce, Lactuca, is derived* from the milky juice that exudes from its stalks when it is cut. This juice, when the plants are young, is of a mild and pleasant bitter, containing a small quantity of the narcotic principle; but this, in the old stems and foliage, and more especially in those plants which are fully exposed to the sun, becomes extremely bitter and notably sedative. A medicine (*extract of lettuce*) is extracted from it, which is said to have the good without the bad effects of opium. In the strongly-scented wild lettuce, which is uneatable, this is very abundant: the plant is cultivated in Forfarshire for this purpose.

2482. *The lettuce* came originally from the Grecian Archipelago, and the name of one kind, the *cos lettuce*, reminds one of the island of the same name. The soporific qualities of the lettuce were very early known, and a lettuce supper has been thought very conducive to repose.

2483. *There are two principal varieties, the cabbage* and the *cos* lettuce, the latter often vulgarly and improperly called *gauze* lettuce. The first is the earliest in season; the leaves are roundish, and the head flat, and close to the ground. The cos lettuce is more upright, and the head is of an oblong form. When very young, the leaves of both are open, and then the cabbage lettuce is preferred; but both have compact round heads when mature, the inner leaves being white, and then the cos lettuce has the finest flavour, and is most employed for salads, the cabbage lettuce being more used for soups. Blanching them prevents, in a great measure, the formation of the bitter acrid and narcotic principle, and renders them more wholesome.

Lettuces may be considered as a cooling summer vegetable, and useful rather as correcting or diluting animal food than as containing much nutriment of itself. It is generally eaten with some condiments, as vinegar, mustard, oil, &c.

SUBSECT. 2.—*Endive* (*Chicorium Endivia*, Linn.).

2484. The history of this plant is little known. It is supposed to have come originally from China and Japan, and to have been introduced into England about 1548. It is remarkable for its elegant leaves, which are much divided at the edges. When suffered to remain green by exposure to the light, they are harsh and bitter, but by tying them up with bass, and keeping them well earthed, they become blanched and succulent, and lose the greater part of their bitterness, retaining only enough to be agreeable. It is grown in abundance in the neighbourhood of London, and is much used as a winter salad, and likewise in soups and stews. The French consume a great quantity of it, raw in salads, boiled in ragouts, fried with roast meat, and as a pickle: they esteem it a wholesome esculent. By judicious culture it may be obtained through the winter, when other salads are not easily procured.

2485. *Chicory*, or *Succory*, called also *wild endive* (*Chicorium Intybus*, Linn.), is a native of this country, growing wild by the road-side; and, though little regarded here, it is much

cultivated on the Continent. Its leaves, in the natural state, are bitter; but by steeping them some hours in water this bitterness is removed, and still more when blanched. They are used as endive in the Netherlands, and particularly the blanched leaves are sold in the markets as an early spring salad. The roots are scraped and boiled, and eaten with sauce and potatoes.

As chickory is very hardy, easily cultivated, and grows upon very poor land where scarcely anything will thrive, chiefly dry calcareous soils, its cultivation has been strongly recommended by Arthur Young and other writers on agriculture, as a food for cattle.

2486. *Mr. Loudon states that* an acre of chicory might be easily grown upon cheap land five or ten miles distant from the place of consumption. The roots may be brought together early in the autumn, and planted and packed close together in a few hundred feet of garden ground to defend them from the frost of winter; then, by laying on some earth and manure early in the spring, the leaves will push into it in a blanched state, and form a very crimp and early salad, the new leaves being derived from the stock of sap elaborated in the preceding year. The adoption of this plan of cultivating chicory may be recommended to many great towns in the north of England, where anything in the shape of a salad is rarely seen until the end of April, and then only tough green lettuces, far more bitter than this invitingly white chicory. Its growth is so rapid that it may be cut three or four times every year.

2487. Its roots may be laid up in a warm cellar, and, if kept from the frost, it will then soon send out a crop of blanched leaves, from which a salad may be obtained in the winter. This property is also taken advantage of on shipboard; the roots are put into a cask with sand, having the sides pierced with numerous holes (or a hamper will do), and the leaves make their way through the holes; this method of forcing is carried on extensively in France.

2488. But there is another use to which the roots of this plant have been applied. Dried and ground, they are employed to a great extent in Holland and Flanders, and likewise in France, as a substitute for coffee. See Chap. XI., Book VIII., "Coffee."

SUBSECT. 3.—*Celery* (*Apium Graviolens*, Linn.).

2489. Celery is also a native of Britain: the wild plant is known by the name of *smallage*, and grows on the side of ditches, and in the neighbourhood of the sea; but although it resembles the cultivated plant considerably, it has a rank, acrid, and disagreeable taste, and is even narcotic and unsafe; yet it has been converted by cultivation into the mild aromatic flavour of the garden celery.

2490. *The blanched foot-stalks of the leaves* are eaten raw, and great care is taken to have them in perfection on the table. The blanching of celery is a striking instance of the effect of the want of light in vegetation. All the colouring matter in plants is developed or assisted in its formation by the sun's rays; heat alone will not produce the same effect: it is light that causes the colour, and hence plants that grow in a dark place are always white: it may be observed that the part of the stem of all plants just below the surface of the ground is white, and that the green does not commence till above the surface. To procure the stalks of the celery as white as possible, they are kept almost entirely covered with earth while growing, and only the tops of the leaves suffered to appear above ground. This management also increases their crispness, and renders them milder flavoured. In Germany celery is boiled and served up as a dish, and the Italians use the green leaves in soup. With us the flavour of celery is employed in the culinary art; and when it is required, and neither the leaves nor stems can be had, the seeds bruised are sometimes employed as a substitute. In the neighbourhood of Manchester celery is grown of an enormous size.

2491. *Celeriac* is a variety of celery having the root of a turnip form, the only part that is eaten. It is much esteemed in Germany and other parts of the Continent, where they boil and eat it when cold, sliced with oil and vinegar as a salad, or employ it in various dishes. It is occasionally imported from Hamburgh, but is little cultivated in England, though very hardy.

2492. *Corn salad*, or *lamb lettuce*, (*Felix olitoria*, Willd.). This is a diminutive annual, common in cornfields and sandy soils. It is occasionally cultivated in gardens, rising to the height of a foot, and is used as a salad. It has long been a favourite plant in France.

SECT. IX.—SMALL SALAD HERBS.

2493. There are certain herbs which are used chiefly in the seed leaf, or when extremely young, for the purpose of procuring salads throughout the year, or at times and in situations where no other can be had. Some of these are also mixed with the larger salad plants to improve their flavours or wholesome qualities. The sorts mostly in use in this country are mustard, cresses, rape, turnip, radish, white cabbage, cabbage lettuce, &c. Some of these may be had at all times of the year, and are cut when not more than a week or ten days old. Being mostly of a warm relish, if suffered to grow too large, so as to run into the rough leaf, they become of a disagreeably strong, hot taste.

SUBSECT. 1.—*Mustard* (*Sinapis*, Linn.).

2494. *There are two varieties of mustard*, the black and the white, both natives of this country, and occasionally growing wild in the cornfields. The black is rather a larger plant than the white, and the leaves darker. The seeds of both, but chiefly the former, are ground to produce the well-known condiment, flour of mustard. It is principally cultivated in Durham.

2495. *Mustard contains* a mild fixed oil of a greenish yellow colour, procured by pressure. The mustard cake, after the expression of the bland oil, when distilled with water, yields an acrid, volatile oil, the principles of which reside in the seeds, but cannot be developed without the aid of water. The pungency of the mustard, when used as food, is developed from the action of the emulsion on a peculiar principle in the same manner as the hydrocyanic acid is developed by the action of water on the bitter almond.

2496. *Mustard is one of the best stimulants* employed to give energy to the digestive organs. It was in high favour with our forefathers. In the "Northumberland Household Book for 1512," p. 18, is an order for an annual supply of 160 gallons of mustard.

2497. *Mustard, in its present form, was not known at our tables previously to* 1729. At that time the seed was only coarsely pounded in a mortar, as coarsely separated from the integuments or skins, and in that rough state made up for use; sometimes it was brought to table whole, or boiled in vinegar. It then occurred to an old woman, of the name of Clements, resident at Durham, to grind the seed in a mill, and to pass the meal through the several processes which are resorted to in making flour from wheat. The secret she kept for many years to herself, and, in the period of her exclusive possession of it, supplied the principal parts of the kingdom, and, in particular, the metropolis, with this article. George I. stamped it with fashion by his approval. Mrs. Clements twice a year travelled to London, and to the principal towns throughout England, for orders, as regularly as any tradesman's rider of the present day; and the old lady contrived to pick up, not only a decent pittance, but what was then thought a tolerable competence. From this woman's residing at Durham, it acquired the name of Durham mustard.

2498. *Mustard is remarkable for the rapidity of its growth*, and, on this account, is frequently sown in the ground as a small salad, together with cress. The seeds strewed on wet flannel, and placed in a warm situation, even by the fireside, frequently shoot out their seed leaves in a day or two—sometimes even in a few hours—a circumstance which is frequently taken advantage of in long voyages. Ships going to the East Indies have boxes with earth placed on the deck, wherein they sow mustard and cress for the purpose of getting salad on the voyage; and the number of crops thus raised is surprising.

SUBSECT. 2.—*Garden Cress* (*Lepidium Sativum*, Linn.).

2499. This elegant small plant is not found wild in England, and is supposed to have been brought from Persia or Cyprus, about 1548. It is considered as the principal of the small salad herbs, and is much cultivated for this purpose, having a very warm, but agreeable aromatic flavour. By the assistance of a little artificial heat, it may be had fresh throughout the winter.

2500. *American cress* (*Barbarea præcox*).—This variety grows wild in Britain in moist or watery ground. It is aromatic and pungent, but rather bitter. It is sometimes cultivated for winter and early spring salad. It is also called *French cress*.

2501. *Winter cress* (*Barbarea vulgaris*).—This also is found wild in Britain in watery places and slow-running streams. In flavour and use it much resembles the last.

SUBSECT. 3.—*Water-cress* (*Nasturtium Officinale*, Linn.).

2502. Water-cress has long been a favourite vegetable, and is found abundantly on the edges of running streams, preferring clean water to that which is muddy. It should be carefully distinguished from the water parsnip (*Sium nodiflorum*, Linn.), which is poisonous, and is often found growing with it.

2503. *The demand for water-cresses in London*, as an adjunct at the breakfast table, has been so great, that, since 1808, they have been cultivated extensively in various places; as at Springhead Valley, near Gravesend, West Hyde, near Rickmansworth, Hackney, Uxbridge, &c. On a gravelly or chalky bottom, shallow excavations are made, into which running water is introduced about a foot deep, and the cress is planted in regular rows, so that a constant succession of young and healthy green shoots, in great perfection, are provided for the market. It is supposed to possess antiscorbutic properties.

SUBSECT. 4.—*Burnet* (*Poterium Sanguisorba*, Linn.).

2504. This hardy perennial plant is indigenous in Britain, found in dry, upland, calcareous soils, and occasionally cultivated in gardens. The leaves are used in salads, put into soups, and form a favourite ingredient in cool tankards. When slightly bruised, they smell like cucumber, and they have a somewhat warm taste. They continue green through the winter, but are now little in use.

SUBSECT. 5.—*Rape* (*Brassica Rapus*, Linn.)

2505. Rape, a native of Britain, is sometimes cultivated in gardens, the seed leaves

being employed for salad, as mustard and cress. It is warm and aromatic. But the chief value of this plant is in the oil that is expressed abundantly from its seeds by a mill.

Sect. X.—Pot-herbs, or seasoning herbs.

2506. This title includes those vegetables which are not used alone as food, but are employed as additions to soups, stews, and various dishes, to increase their nutritious qualities, or to give them flavour. Many of them would prove actual poisons if eaten in quantity; but they owe their useful properties to their stimulating nature and powerful flavour, by which they render many kinds of food palatable that would otherwise be insipid: some are used medicinally. They are of very ancient use, and are to be found in every garden, from that of the mansion to that of the cottage.

Subsect. 1.—*Parsley* (*Apium Petroselinum*, Linn.).

2507. This herb, of extensive use in the culinary art, was known to the ancient Greeks, but the time of its introduction into Britain is not ascertained. Though not indigenous, it is so common, and so frequently sows itself, as to be frequently taken for a native.

2508. *There are several varieties*: 1. The *plain-leaved*, not much cultivated, though the only one used formerly. It is now nearly banished from the garden, because the curled varieties are much more elegant; but there is another reason for its being laid aside—its great resemblance to a poisonous British weed, the *fool's parsley*, or *lesser hemlock* (*Æthusa cynapium*). The leaves of the latter are of a darker green, and, when bruised, have a very disagreeable smell, quite different from that of the common parsley. When in flower, the fool's parsley is easily distinguished by what is called its beard, that is, by the three long pendant leaves of its involucrum. 2. The *curled-leaf parsley*, which may be safely used, being quite unlike the hemlock; it is the best, both for its flavour and appearance on the dish as a garnish. Sheep, hares, and rabbits are extremely fond of this herb, and it is said to impart to their flesh a fine flavour. It is useful to know that parsley is poison to parrots.

Naples parsley, or *celery parsley*, is a variety between parsley and celery, and is used as the latter.

Hamburgh parsley is a variety cultivated for the roots, which grow to the size of small parsnips; these boil exceedingly tender and palatable, are very wholesome, and may be used in soup or broth, or to eat with meat like carrots or parsnips.

2509. *Purslane* (*Portaluca oleracea*, Linn.).—This plant is a native of South America. The young shoots and succulent leaves were more used formerly than at present as a cooling ingredient in spring salads.

Subsect. 2.—*Tarragon* (*Artemisia Dracunculus*, Linn.).

2510. This herb, of a fragrant smell and aromatic taste, is used in France, on account of its pungency, to correct the coldness of salad herbs; an infusion in vinegar makes a good fish sauce, and it is also an ingredient in pickles, and in soups and other dishes particularly in French cookery. It is said to be originally a native of Siberia.

Subsect. 3.—*Fennel* (*Anethum Fœniculum*, Linn.).

2511. Fennel grows wild with us in chalky soils, particularly at Feversham, but has been long cultivated in the garden. The leaves, from their elegance, are often used as a garnish or ornament to various dishes. They are boiled in soups and fish sauces, and some use them as salads. They have too powerful taste in their natural state to be used, except as a flavouring ingredient. The French use it frequently in fish soups; but the Italians, by blanching the plant in their warm climate, where it grows rapidly and to a large size, obtain it in a state very like celery, with a strong thick stalk: the strong taste is then destroyed, and they eat it with oil, pepper, and vinegar

Subsect. 4.—*Dill* (*Anethum Graveolens*, Linn.).

2512. This plant resembles fennel considerably, but is smaller. It is used in pickles, particularly with cucumbers, and sometimes in soups and sauces, but chiefly for medicinal purposes. It is a native of Spain.

Subsect. 5.—*Horseradish* (*Cochlearia Armoracea*, Linn.).

2513. This well-known accompaniment of roast beef is a native of England, and a hardy plant, growing wild in wet ground, but it has been long cultivated in gardens also. It is occasionally used in sauces, and in winter salads. Its acrid taste depends upon an essential oil of great pungency, which may be obtained by mashing and distilling with water

2514. *The oil of horseradish*, which is frequently procured in Sweden, is extremely volatile, quickly evaporates, and fills the room with the peculiar flavour of the plant. On account of the great volatility of its oil, horseradish, when dried, loses its flavour, and becomes unfit for the purpose to which it is applied: hence it should never be preserved by drying, but by keeping moist and cold through burying in sand; and for this reason it is that, when scraped for the table, it almost immediately spoils by exposure to the air, the volatile oil evaporating.

SUBSECT. 6.—*Nasturtium* (*Tropæolum*, Linn.).

2515. This elegant plant, called sometimes *Indian cress*, is a native of Peru, but grows very well with us. Its young leaves and flowers being of a warm nature, are sometimes used in salads, as the cress; its fine yellow flowers are employed to garnish dishes; and its seeds, when pickled, form a good substitute for capers.

SUBSECT. 7.—*Chervil* (*Scandix Cerepolium*, Linn.)

2516. Chervil is a native of various parts of the Continent of Europe, and is sometimes observed naturalized in our gardens. The tender leaves are used in salads, and the curled variety for garnishing. There is a kind cultivated in the gardens of Paris (*Cerfeuil frisé*) with beautifully frizzled leaves. The roots are poisonous.

SUBSECT. 8.—*Pot-marigold* (*Calendula Officinalis*, Linn.).

2517. This is a native of France and Spain, and naturalized here since 1573. The flowers were formerly much used in broths and soups, and the plant is still frequently to be met with in cottage gardens.

SECT. XI.—SWEET HERBS.

2518. *Of sweet herbs some are cultivated for culinary purposes, and others for the perfumer and druggist.* Much of the natural fragrance of the fields is owing to the aroma of this class of plants, the *Labiatæ*; and many of them yield an aromatic essential oil by distillation. The most useful of this class are thyme, sage, mint, marjoram, savory, basil, rosemary, lavender, tansy, and balm. It is said that mint, and many other plants which yield an essential oil, afford it of a more penetrating odour in England than in the south of Europe, and that all strong-smelling plants lose their odour in a sandy soil.

SUBSECT. 1.—*Thyme* (*Thymus*, Linn.).

2519. We have two species of wild thyme in Britain, which differ from the common thyme cultivated in our gardens for culinary purposes.

Garden thyme (*Thymus vulgaris*, Linn.) is a native of the south of Europe; it is a shrubby evergreen about a foot in height, and is more delicate in its aromatic flavour than wild thyme; its young leaves and tops are used in stuffings, soups, and sauces.

Another smaller species, *lemon thyme* (*T. citriodorus*, Linn.), has a strong perfume, like the rind of lemons, and is used for some particular dishes.

A variety called *Frankincense thyme* is cultivated in Norfolk. Thyme was used by the Romans to flavour cheese.

SUBSECT. 2.—*Sage* (*Salvia Officinalis*, Linn.).

2520. Sage is originally a native of the south of Europe, but has been long an inhabitant of our gardens. There are several sorts, as the red, the green, the small-leaved, and the broad-leaved balsamic. Its chief use in cookery is in stuffings and sauces, to correct the too great lusciousness of strong meats, as goose, duck, or pork; its taste is warm, bitterish, and aromatic, qualities which depend upon an essential oil. The red has the most agreeable and fullest flavour for this purpose; the green is the next; the last two are used in medicine. Sage had great reputation formerly on account of its medicinal qualities; but at present these do not appear to be much regarded. It possesses, however, some aromatic and astringent powers; and a decoction, or sage tea, is found serviceable in debility of the stomach, and in nervous cases. The Chinese sometimes prefer it, it is said, to their own tea. It is useful as a gargle in sore throat, and it is grateful and cooling. The broad-leaved balsamic species is the most efficacious for its medical qualities, and as a tea herb. It is also introduced into cheese.

SUBSECT. 3.—*Mint* (*Mentha*, Linn.).

2521. *There are several species of mint* that grow wild in Britain, found chiefly in low, moist situations, and they are likewise cultivated. They are all distinguished by a well-known and peculiar aromatic flavour, and some are employed in culinary preparations; others yield a highly odoriferous and pungent essential oil by distillation. None of them are in the least poisonous; but they are very different both in appearance and their uses.

Spearmint (*Mentha viridis*, Linn.).—This is the common mint cultivated in our gardens, and employed in different processes of cookery, as having the most agreeable flavour; the leaves are sometimes boiled in certain dishes, and afterward withdrawn. They likewise form an ingredient in soups, and are sometimes used in spring salads. They are also dried for the winter, and in this manner lose none of their flavour. Mint is stomachic and antispasmodic, and is useful in flatulencies; these qualities probably led, independently of its agreeable flavour, to its universal use in pea soup, in which it is a valuable ingredient.

Peppermint (*M. piperita*, Linn.).—This is cultivated entirely for the essential oil distilled from it. Its taste is stronger, warmer, and more pungent than spearmint, and leaves a sort of coolness on the tongue after tasting it. It yields a little camphor, to which its taste is partly owing, and its medicinal uses are well known

Pennyroyal mint (*M. pulegium*, Linn.), has a warm, pungent flavour, but less agreea-

ble than common mint. It is employed in some particular dishes in cookery, and formerly chiefly for medical purposes, but is now little used.

Subsect. 4.—*Marjoram* (*Origanum*, Linn.).

2522. *There are several species of marjoram*, but that which is preferred for cookery, and which is cultivated in our gardens for this purpose, is the *sweet marjoram* (*O. marjorana*, Linn.), also called knotted marjoram. It is a native of Portugal, and the seeds seldom ripen here; they are brought from France. The leaves are dried as a seasoning herb, having an agreeable aromatic flavour. There is also a *winter sweet marjoram* (*O. Heracleoticum*, Linn.), a native of Greece, used for the same purposes. *Pot marjoram* (*O. onites*, Linn.) is another variety originally brought from Sicily, which does not ripen its seeds here. *Common* or *wild marjoram* (*O. vulgare*, Linn.) is found growing in our fields, chiefly among copse-wood on calcareous soils. This has nearly the same flavour, but is inferior, and is only used when the others are not at hand. All these are favourite ingredients in soups, stuffings, &c.

Subsect. 5.—*Savory* (*Satureja*, Linn.).

2523. Of this aromatic herb there are two varieties, the summer and winter savory, from the time of year when they may be gathered. They are natives of Italy, but are cultivated in our gardens for the use of the cook. The leaves are gathered and dried.

Subsect. 6.—*Basil* (*Ocymum*, Linn.).

2524. This plant is highly aromatic, its odour resembling that of cloves. There are two principal varieties, the *sweet* or *larger basil* (*O. basilicum*, Linn.), and the *bush* or *least basil* (*O. minimum*, Linn.), both natives of the East Indies. Though little employed in English cookery, they are favourite herbs with French cooks, on account of their flavour in highly seasoned dishes, and the leaves are used in small quantities in soups and salads. The Chinese, also, are said to flavour their dishes with basil.

2525. *Clary* (*Salvia sclaria*, Linn.).—This is a native of Italy. Its leaves are sometimes used in soups, though some dislike its odour. A medicinal wine is made from its flowers.

Subsect. 7.—*Rosemary* (*Rosmarinus Officinalis*, Linn.).

2526. This is also a highly aromatic plant, a native of the south of Europe, and derives its name from its beautiful appearance when glittering with dew on the seashore. Its leaves have a fine aromatic fragrance like camphor, of which, indeed, its oil contains one fourth. From an old opinion that rosemary had the property of strengthening the memory, this plant has been made an emblem of remembrance or fidelity; which probably led to the custom in some parts of the west of England and Wales of wearing branches of it at weddings and funerals. Infusions of the leaves are put into some drinks; but its chief use is in the flowers giving their fragrance to Hungary water, used as a cosmetic. It also enters into the composition of Eau de Cologne, and four-thieves-vinegar.

Subsect. 8.—*Lavender* (*Lavandula Spica*, Linn.).

2527. Lavender is a highly odoriferous plant, scarcely used in cookery, but is extremely valuable on account of its agreeable perfume. The leaves and flowers are both aromatic, and when dried they are put among linen. From their flowers the well-known perfume, lavender water, is prepared. The ancients employed this plant to aromatize their baths, and to give a sweet scent to water in which they washed; hence their generic name, *Lavandula*. It grows spontaneously in the south of Europe, and has been cultivated in England since 1568: a great deal is grown near London, and sold to the druggists, perfumers, and distillers. The essential oil, when procured pure, is sometimes called *oil of spike*. Sixty ounces of flowers yield only an ounce of this oil; hence its high price and frequent adulteration.

Subsect. 9.—*Tansy* (*Tanacetum Vulgare*, Linn.).

2528. Tansy grows wild in Britain, and is cultivated in gardens. Its leaves, having a powerful aromatic bitter, are sometimes chopped or bruised to put into certain puddings, or the juice alone is so employed; its use is very ancient. There are three varieties: the *plain* and *curled leaved*, and the *variegated*.

Subsect. 10.—*Saffron*.

2529. This is the dried stigmata of a bulbous plant, the *Crocus sativus*, once much cultivated in England, and used in seasoning dishes in the time of Richard II. It is now chiefly employed as a colouring matter for cheese and butter. It is still cultivated near Glazenwood, in Cambridgeshire, and at Stapleford. When good, saffron has a beautiful yellow colour and an agreeable odour; it yields its active principle, an essential oil, to water and spirit. Dr. A. T. Thomson, in his Materia Medica, states that it excites the nerves of the stomach, and is in some degree narcotic; its incautious use has sometimes been attended with dangerous consequences. It is sometimes adulterated with safflower and marigolds; but the adulteration is easily detected, for the petals of these

: distinct from the stigmata of the crocus. Some saffron is imported t, but it is inferior to the English.

SUBSECT. 11.—*Laurel or Bay Leaves.*

s are often mentioned in the receipts for cookery. As there is some pect to the name, it is necessary to put this matter in a clear light. has been applied to two trees very different. The proper laurel-tree nn.), the classical laurel, is commonly called the bay-tree, or sweet eaves, though slightly aromatic, are harmless, and are seldom, if ever, ry. A species of the genus Prunus (*Prunus laurus-cerasus*, Linn.), ee, has leaves much resembling those of the laurel, whence the name ~~laurus-cerasus~~, or *cherry laurel;* this is also sometimes called bay, and is the sort employed for its flavour. The cherry laurel is an evergreen tree, cultivated in gardens; its leaves are large, thick, oblong, glossy, pointed at both ends, and slightly indented. These latter leaves have a bitter styptic taste, accompanied with a flavour resembling that of bitter almonds, or other kernels of the drupaceous fruits. This kernel-like flavour being agreeable, has occasioned them to be employed for culinary purposes, especially in custards, puddings, blanc mange, &c., and then, as the proportion of the sapid matter of the leaf is usually diluted in a large proportion of milk, bad effects have seldom or never ensued from its use. But as the Prussic acid developed by the action of water on laurel leaves is known to be a violent poison, it is necessary that the public should be cautioned with respect to its properties, lest too much should be used on some occasions; since in the process of making laurel water by distillation it is sufficiently powerful to occasion death, and persons have been poisoned by drinking laurel water by mistake.

SECT. XII.—PLANTS USED IN TARTS, CONFECTIONERY, AND DOMESTIC MEDICINE.

2531. The list of this class of plants, as used formerly, was more considerable than at present, many of those employed by the ancient herbalist having given way to the abundance of foreign spicery and the more powerful medicines of the chemist. Those which we shall describe are still cultivated, and are all useful, particularly in retired situations in the country, where a druggist is not at hand.

SUBSECT. 1.—*Rhubarb* (*Rheum*, Linn.).

2532. This is one of the most useful and best of all the productions of the garden that are put into pies and puddings. It was comparatively little known till within the last twenty or thirty years, but it is now cultivated in almost every British garden. The part used is the footstalks of the leaves, which, peeled and cut into small pieces, are put into tarts, either mixed with apples or alone. When quite young, they are much better not peeled.

2533. *The culture of the tart rhubarb has increased very rapidly of late*, in consequence of the great demand for it, and, consequently, it is at present sold at a very cheap rate. It comes in season when apples are going out.

2534. There are several varieties of this plant: *common rhubarb* (*Rheum rhaponticum*, Linn.), called also *Monk's rhubarb*, is a native of Asia, but has been cultivated in England since 1573. It is much improved by blanching.

The Hybrid rhubarb (*Rheum hybridum*, Linn.) is also a native of Asia, but from a more northern part. It was first cultivated as a garden plant by Dr. Fothergill in 1778, and is now in general use, the leaves being much larger and more succulent than the common sort. *Elford rhubarb*, or *scarlet rhubarb* (*Rheum undulatum*), is considered by gardeners to have the finest flavour, and, when cooked, is of a bright scarlet; it is free from that peculiar taste which occasions common rhubard to be disliked by some persons. *Turkey rhubarb* (*Rheum palmatum*) is a most elegant plant, but its leaf stalks are small. It is the root of this which forms the well-known medicinal drug, but its virtues are not so well developed in this climate as in Tartary, from which the rhubarb of the druggist is brought to us by the way of Turkey, India, and Russia.

SUBSECT. 2.—*Gourd* (*Cucurbita*, Linn.)

2535. *The gourd constitutes a large family;* some varieties are very beautiful, and are cultivated for ornament; some grow to an immense size, and are kept more as matters of curiosity, and others are cooked in a variety of ways. In warm climates, and particularly when well manured, it grows luxuriantly in the open air, and is extremely ornamental. It is much employed as food on the Continent of Europe and in America. It is extensively used in soups, stews, and pies, and is also sent to table boiled and served with toast and melted butter, or fried with butter, the last being by far the best mode of cooking it. The tender shoots and young leaves are boiled as greens or spinach, and the flowers and young shoots make an excellent dish fried. It is only beginning to be appreciated in Britain, though one variety, the *pompion*, or *pumpkin* (*C. Peto*, Linn.), has long been eaten in England by the poorer classes, generally mixed with apples and baked in a pie: it is sometimes boiled with milk; this is, however, the most insipid of the

gourds. A great many ways of dressing the different varieties of pumpkins may be seen in the French and Italian books on cooking, and in the Gardener's Magazine, vols. vii. and viii. There are many other varieties cultivated in Europe, as the *Turban pumpkin*; the *melon pumpkin*, or *squash*; *American gourd*, or *Mammoth gourd*, which grows sometimes to the enormous weight of two hundred pounds, and used in Paris boiled to eat with meat as a substitute for potatoes and carrots. In many of the French provinces, where it is extensively cultivated, cows, hogs, and other cattle are fed upon gourds, and from the seeds large quantities of oil are expressed, which is used both for food and burning in lamps.

2536. *The botanical name* (*Cucurbita*) *is derived* from the resemblance which many species bear to certain vessels employed by chemists. In various parts of the world the shell is converted into bowls and other domestic utensils for holding water. The bottle gourd has a long neck and capacious ball, like a flagon.

2537. *Vegetable Marrow* (*C. ovifera*).—This is a variety of gourd which has been lately introduced into Britain, and is already cultivated to a considerable extent. It appears to have been brought to us from Persia by one of our East India ships. In shape it nearly resembles the cucumber, but is yellow when ripe, and attains the length of about nine inches. When young, it is excellent fried in butter; when half grown, it may be dressed in several ways, and has a peculiarly soft and rich flavour. It is also dressed plain boiled, and eaten with butter, or stewed in slices with rich sauce; and it is made into pies. The tender tops may be used as substitutes for greens.

Subsect. 3.—*Angelica* (*Archangelica*, Linn.).

2538. This herb is sometimes found native in Scotland, but is more abundant in the most northern parts of Europe, as Lapland and Iceland. The whole plant is powerfully aromatic. The seeds are employed to flavour ardent spirits or the choicest liquors; and in Sweden, Norway, and Lapland, the leaf-stalks are peeled and eaten raw as a great delicacy, or boiled with meat and fish. In England and France they are candied by the confectioner. The root, as well as the leaves and seeds, are employed for medicinal purposes, and in Lapland is chewed like tobacco.

Subsect. 4.—*Anise and Cummin* (*Pimpinella Anisum*, Linn.).

2539. The seeds of the anise, which is a native of Egypt, have been long used in this country, in confectionery and for distillation: they are imported from China, and Alicant, in Spain. Anise is somtimes cultivated in our gardens, and its leaves are used, like fennel, as a garnish and for seasoning.

2540. *Cummin* (*Cumminus*, Linn.).—The seeds are used in the north of Europe as a warm and stimulating spice in ragouts and other dishes, and are also put into liquors.

Subsect. 5.—*Coriander* (*Coriandrum Sativum*, Linn.).

2541. This plant, of eastern origin, has been long cultivated in England for its seeds, which are highly aromatic, and form one of the less agreeable spices: they are employed by the distiller in flavouring spirits, by the confectioner for incrusting with sugar, and by the druggist in medicine. Its tender leaves are also sometimes used in soups and salads, and in Peru the seeds are employed in great excess to season their food.

Subsect. 6.—*Caraway* (*Carum Carui*, Linn.).

2542. The caraway is a native of this country, and is found growing in meadows. It is likewise cultivated for its seeds, large quantities of which are produced in Essex. The seeds have a pleasant aromatic odour, and a sweetish, warm, pungent taste, depending upon an essential oil, which is easily extracted by rectified spirit, and partly so by water. They are employed in confectionery, in cakes, biscuits, &c.; in medicine as a carminative, and for flavouring spirituous liquors; and the young leaves are sometimes used in soups: formerly the roots were eaten as parsnips, and by some are thought to be not inferior.

Subsect. 7.—*Rue and Hyssop* (*Ruta Graveolens*, Linn.).

2543. Rue is a hardy evergreen shrub, cultivated time out of mind in our gardens, but supposed to be originally a native of the south of Europe. It has a strong, ungrateful odour, and a bitter, hot, and penetrating taste. It is employed only for its medicinal qualities.

2544. *Hyssop* (*Hyssopus officinalis*, Linn.).—This, like the last, is only used in medicine; the leaves and young shoots rarely as a pot-herb.

Subsect. 8.—*Chamomile* (*Anthemis Nobilis*, Linn.).

2545. This very useful and generally-used aromatic bitter grows wild in England. It is cultivated on account of its flowers, an infusion of which forms an excellent stomachic, known by the name of *chamomile tea*. Though the double sort is most raised by gardeners, the single is the best and strongest as a medicine. The flowers are kept dried in bags. The active principle of chamomile is a resinous substance called *piperina*, discovered by Dr. A. T. Thomson.

SUBSECT. 9.—*Elicampane* (*Inula Helenium*, Linn.).

2546. This aromatic plant was formerly in great repute in England for its medicinal virtues, and was to be found in every physic garden. It is still cultivated, and the root is candied as a stomachic. It is found wild in moist pastures in the south of England.

SUBSECT. 10.—*Liquorice* (*Glycyrrhiza Glabra*).

2547. This medicinal plant is a native of the south of Europe, but has been cultivated in this country since 1562, chiefly for the use of brewers and distillers. The liquorice of the shops is the juice of the roots obtained by expression, decoction, and inspissation, and is manufactured only in Sicily and Spain; hence the name Spanish juice. It grows so abundantly in these countries and in Languedoc, that it is considered as a weed like the horseradish here, and is looked upon as a great nuisance to the cultivator. Its roots penetrate to a great depth, and are difficult to eradicate.

SUBSECT. 11.—*Wormwood* (*Aremisia Absinthium*, Linn.).

2548. The intense bitter of this plant is so great as to render it proverbial. Its odour is strong, and, though fragrant, yet to many persons it is disagreeable and nauseous. It grows wild in England, but is likewise cultivated for several purposes, though less used than formerly. It has tonic properties, and is sometimes employed as a stomachic. The French beverage or liqueur, called *eau d'absinthe*, thought to create an appetite, is prepared from wormwood, by the addition of alcohol and subsequent distillation. The active part seems to be the extractive, for the essential oil which it contains is not in the least bitter. Before the use of hops was known, wormwood was much employed in the composition of beer or ale: for this purpose it was gathered when in seed, and dried; some prefer its flavour to that of the hop.

SUBSECT. 12.—*Balm* (*Melissa Officinalis*, Linn.).

2549. Balm, formerly much employed in medicine, is still found to make a very grateful and useful drink in fevers. The herb, in its natural state, has a weak aromatic taste, and a pleasant smell, somewhat of the lemon kind. It was originally brought from the south of France. The leaves may be kept dried in the sun or oven, and preserved for use.

SECT. XIII.—PLANTS USED ONLY IN PRESERVES AND PICKLES.

2550. Many of the plants already described, as well as many foreign plants and fruits, are made into preserves and pickles. The following are a few that are not employed in any other way.

SUBSECT. 1.—*Caper* (*Capperis Spinosa*, Linn.).

2551. Capers, so much employed in sauces, are the unopened buds of a low trailing shrub or bush that grows wild like brambles in the fissures of rocks in Greece and the north of Africa, and is cultivated in the south of Europe. They are pickled in salt and vinegar, and come to us from Italy, Sicily, and the south of France; the best are from Toulon.

SUBSECT. 2.—*Samphire* (*Crithmum Maritimum*, Linn.).

2552. Samphire is a native of Britain, and is found growing on rocky cliffs by the sea, and in dry stone walls. The danger incurred by gathering it is described by Shakspeare in a well-known passage in King Lear. It is not easily cultivated, but is chiefly gathered in its wild state for pickling, and as an addition to salads. It is crisp and aromatic. *Golden samphire* and *marsh samphire* are varieties likewise found upon the seashore, or in salt marshes, and applied to the same use.

SUBSECT. 3.—*Tomato, or Love-apple* (*Solanum Lycopersicum*).

2553. This is a native of South America, and *Tomato* is the Portuguese name. The fruit is about the size of a small apple, contains a very agreeable acid, and is now much used in gravies, soups, and sauces. It is also served at table boiled or roasted, and sometimes fried with eggs. When green, it makes a good pickle and catchup, and is found in our vegetable markets; even in its unripe state it makes an excellent sauce, like apples or gooseberries, for roast pork or goose: when fully ripe, it makes an excellent store sauce.

2554. *The egg plant* (*Solanum esculentum*, Linn.) is allied to the last, and, though not uncommon in our green-houses, is seldom employed in this country as an article of cookery: it has less flavour than the love-apple; but it is more employed on the Continent, and in warmer latitudes, where its growth is attended with less trouble; it enters into stews and soups, and it is eaten as fritters, sliced and fried with oil or butter; it then forms a pleasant variety of esculent.

SECT. XIV.—POISONOUS PLANTS THAT GROW WILD IN BRITAIN.

2555. Every gardener should be acquainted with the following plants, that he may point them out, and enable such persons as are in search of edible wild plants to avoid them:

Chelidonium majus	Atropa belladonna	Digitalis purpurea.
Cicuta virosa.	Datura stramonium.	Helleborus fetidus.
Colchicum autumnale.	Hyoscyamus niger.	Juniperus Sabina.
Œnanthe crocata.	Solanum dulcamara	Scrophularia aquatica
The leaves of Prunus lauro-cerasus, though the berries are used in puddings.	Solanum nigrum.	Asclepias Syriaca.
Aconitum Napellus.	Lactuca virosa.	Bryonia dioica.
Aconitum lycoctonum	Apium graveolens	Euphorbia Lathyrus.
Actæa spicata.	(The last two plants, in a cultivated state, afford lettuce and celery; but wild, in hedges and ditches, they are poisonous.)	Euphorbia amygdaloides.
Rhus toxicodendron.		Mercurialis perennis.
Æthusa cynapium.		Mercurialis annua.
		Periploca Græca.
	Conium maculatum.	Veratrum album.

Professor Burnett observes that, lately, seventeen convicts at Woolwich were poisoned by eating the roots of Œnanthe crocata, which grows wild near Woolwich, and four of them died. Other similar instances are recorded in the Reports of the Medico-Botanical Society. A variety of Œnanthe, though dangerous when wild, is innocuous when improved by cultivation, and is eaten at Angers, in France.

SECT. XV.—ESCULENT FUNGI

2556. *Fungus is the botanical name* for a very numerous tribe of plants, which are distinguished from other vegetables, not only by their singular forms, but by their chemical composition, yielding, upon analysis, not only the usual components of the vegetable kingdom, carbon, oxygen, and hydrogen, but likewise a large proportion of nitrogen, by which they approach more nearly to the nature of animal flesh. Dr. Darwin observed, long ago, that all the mushrooms cooked at our tables, as well as those used for catchup, possessed an animal flavour; and soup enriched by mushrooms only has sometimes been supposed to contain meat.

2557. *In this numerous tribe, a large proportion are poisonous*, a few are wholesome, and a vast number are still unknown as to their action upon the human constitution. The poisonous and wholesome species are often very similar; and as it is difficult to distinguish between many of them, even by botanical characters, the use of wild mushrooms is very unsafe. The few that it is customary to eat and to cultivate are known to those who are in the habit of collecting them, and no one should venture upon eating a species they do not understand. It is a remarkable circumstance that certain species that are eaten as food in one country are rejected as poisonous in another, which seems to show that their deleterious properties are owing to climate, situation, or accidental circumstances, rather than any specific peculiarity. In some parts of Europe, as Russia, Poland, and parts of Germany, there are above thirty species growing wild that are used as food, and cooked or preserved in various ways, whereas in Britain only two are generally eaten.

2558. *The garden, or cultivated mushroom* (*Agaricus campestris*, Linn.).—This species, which is considered as the best, and is the most usually eaten in England, is cultivated in gardens; but it is also found abundantly springing up wild in rich open pastures. It is distinguished from the poisonous kinds called *toad stools* by its having pink or flesh-coloured gills or under side, and by its invariably having an agreeable smell. When young they are of a roundish form like a button, the stalk as well as the button being white, and the fleshy part being very white when broken, the gills within being livid. As they grow larger, they expand their heads by degrees into a flat form, and the gills underneath are at first of a pale flesh-colour, but as they stand long become blackish or brown. The poisonous kinds are mostly all brown, and generally have a rank, putrid smell. The edible mushrooms seldom grow in woods, but many of the poisonous sorts are to be found there. Mushrooms are stewed or boiled, and are employed in flavouring many dishes. They are also pickled and dried, and when reduced to powder, and kept in this state in close bottles, they are very useful in the season when they do not grow. The wild mushrooms of the same species are considered superior in point of flavour to those raised in the garden; but the latter are safer on account of the risk of gathering improper sorts. *Catsup*, or *catchup*, is made from mushrooms by mixing salt and spices with their juice. The young, when globular, called *buttons*, are best for pickling.

2559. *A. pratensis* is a much esteemed species, known by the name of *champignon*: the best grow in parks and dry pastures, where the turf has not been ploughed up for many years; they have a finer flavour than the garden mushroom; the gills are cream-coloured. These are much employed for catchup and in stews; but it is said that they are apt to be hard and leathery, in which state they are indigestible, and they are so like some poisonous kinds that they should be gathered with caution.

Besides these, however, there are several edible mushrooms in this country; and in particular districts, where the inhabitants are well acquainted with them, they are used; but, as we have before stated that there are many which are poisonous, we would advise those who are not very conversant with their characters to abstain from gathering them.

Mushrooms vary much in size: some are only an inch or two in diameter, others have been known to measure eight or ten inches across. Dr. Withering mentions a species on the seacoast of Cornwall which has the cap eighteen inches in diameter, and the stem as thick as a man's wrist; and one was gathered in a hot-bed in Birmingham that weighed fourteen pounds.

The manner of propagating the fungus tribe is remarkable and peculiar, and the properties of some of those which are found in other parts of the world are extraordinary. Besides those which are powerful poisons, some are medicinal; and one species in the northeast part of Asia is employed to produce intoxication.

All mushrooms require to be very well cooked, particularly those which are large.

CHAPTER IX.

DESCRIPTION OF THE FRUITS USED AS FOOD IN BRITAIN.

SECT. I.—GENERAL OBSERVATIONS.

2560. The most agreeable, if not the most useful, species of vegetable food consists of fruits. The hardy fruits, or such as grow without the aid of artificial heat, are valuable as food, independently of their employment in the dessert; and some of these, as the apple and the gooseberry, &c., are easily within the reach of the humbler classes.

2561. *The most important of our fruits were originally the produce of warm countries*, and have, by the art of cultivation, been gradually acclimated to temperate regions. Those enlightened nations of antiquity, the Greeks and Romans, introduced into Italy many fruits from countries which they subdued, and it was their constant practice to extend these advantages to their conquests. In this manner the fig, the orange, the peach, plum, cherry, apple, and pear, almonds, olives, and a great variety of others, mostly natives of Asia, have been spread over Europe; and thus war, productive of so many evils, has, in the early stages of society, contributed to diffuse the arts of civilization. Before the invasion of the Romans, Britain probably possessed no other than the wild fruits of Northern Europe, the crab, the sloe, the hazelnut, and the acorn. Much was due to the Anglo-Saxon monks, who, in their time, were probably the only gardeners, and who bestowed much care in the cultivation and improvement of some of our best fruits; their vineyards and orchards were in great perfection from the twelfth to the fifteenth century.

2562. *The Crusades*, unjust as they were, contributed to the improvement of European society; and the monastic gardens owed some of their choicest fruits to the ecclesiastics who had accompanied the expeditions to the Holy Land. In the same manner, the Spaniards introduced the European vegetables and fruits into America, as the English missionaries are now doing in the islands of the Pacific, and in Africa.

2563. *The discovery of the New World*, and the extension of commerce in the reign of Queen Elizabeth, added considerably to the number of our fruits and vegetables; and this princess herself set an example as a horticulturist. Under the Stuart family, gardening was greatly improved; and in each succeeding reign it made a steady progress.

2564. *At present* every part of the globe is examined by our botanists, and constant additions are being made to our knowledge of the vegetable kingdom. The modern improvements in science, and the art of gardening, have enabled us to add to our list numerous tropical plants, some of which, though at their first introduction they were kept entirely in stoves, are now planted out, and can bear the rigour of our ordinary winters; from which it may reasonably be expected that they may be so far acclimated here as to ripen in the open air. Already we find pineapples and melons, formerly so rare, now by no means uncommon in Covent Garden market, and sold at very moderate prices.

2565. *On this subject Sir Joseph Banks has observed:* "It does not require the gift of prophecy to foretell that ere long the aker and the avocado pear of the West Indies, the flat peach, the mandarin orange, and the litchi of China, the mango, the mangostan, and the durion of the East Indies, and possibly other valuable tropical fruits, will be frequent at the tables of opulent persons; and some of them, perhaps in less than half a century, be offered for sale every market-day in Covent Garden."

2566. *The extended introduction of inter-tropical fruits* begins much to interest the admirers of these natural productions, and trials may be made without much additional expense in our hot-houses, now fitted up in such perfection. The banana, or plantain, has been fruited in Britain nearly forty years ago, and frequently since. When the hothouse is lofty enough, it is a magnificent plant, and makes an appearance even surpassing what it exhibits in its native country, where its ample leaves are often torn in pieces by the winds. The mango has been also fruited, both in France and England; and if some of the best varieties were imported with care from Jamaica, there is little doubt that, with proper cultivation, they might be had on the table as easily as the pineapple.

But the orange trade displays in a singular manner the advantages which we derive from the present commercial system. Though these are fruits of climates much warmer than ours, yet we obtain them at a price little higher than that of our domestic fruits. Nor should we forget, while on this subject, that some of our wild fruits, as the berries, perhaps deserve to be made the subject of experiment how far they may be capable of improvement, and whether it may not be judicious to attempt their melioration.

2567. *Great advantage has been derived of late to the cultivation of fruits in general by the establishment of horticultural societies*, particularly the London and Caledonian, the

"Transactions" of which contain much valuable information on this interesting subject: great pains have been bestowed to select and disseminate the best varieties.

2568. *The fruits which we propose to describe* we shall divide, with Mr. Loudon, into,

1. *Kernel fruits*, or *pomes:* those having the seeds enclosed in membranous cells, including the apple, pear, quince, and medlar. These are also called fleshy fruits.
2. *Stone fruits:* having the seeds enclosed in hard nuts covered with flesh, or a sarcocarp, as the peach, nectarine, almond, apricot, plum, cherry, and olive.
3. *Pulpy fruits:* having the seeds lying among the pulp, as the pineapple, grape, melon, cucumber, fig, and tamarind.
4. *The orange tribe:* this contains a well-known group, the sweet orange, the bitter orange, lemon, citron, and shaddock.
5. *Berries:* a smaller kind of pulpy fruits, as the gooseberry, current, raspberry, strawberry, mulberry, elderberry, barberry, whortleberry, cranberry, blaeberry, blackberry, dewberry, juniper berry, and service berry.
6. *Exotic fruits:* occasionally imported, or but little known in England, as the pomegranate, plantain, banana, mango, mangostan, aker, bread-fruit, durion, guava, litchi, jujube, juvia, alligator, or avocado pear, anchovy pear, custard apple, and papaw.

2569. *No class of substances employed as food varies more in their dietetic qualities than fruits*, which, though extremely salubrious when used judiciously, are frequently injurious, particularly to the invalid. It is essential, in order to have a just view of this subject, to discriminate accurately between different species, the state of ripeness, the time and circumstances under which fruit is eaten, as well as the constitution of the consumer. There are three modes in which fruits may be used as food: in a crude state, dried, or prepared by the art of cookery. A very great change takes place as they advance towards maturity from the unripe state. In the latter, in general, acids and astringent matter abound, which is often converted into sugar when they ripen; hence the injurious properties of many unripe fruits which are perfectly wholesome when ripe. Similar changes in their constituent principles frequently take place during the operation of cooking; as, for instance, a portion of the acid of apples becomes sugar; and, in general, numerous fruits, very indigestible in their raw state, when boiled, roasted, or stewed, form excellent food. The acid of unripe fruits is usually objectionable, but that of fruits in their ripe state is often cooling and salutary, when sufficiently diluted. Those which, when ripe, have about an equal mixture of acid and sugar, as the strawberry, raspberry, grape, and orange, are particularly agreeable and wholesome in the warm part of the year, when they are in the most perfect condition. Of our natural fruits, the cherry and the nut tribe are the least wholesome.

2570. The drying of some fruits, as raisins, not only enables the inhabitants of cold countries, through the medium of commerce, to enjoy a species of food which their climate has not permitted them to cultivate, but, by this process, the watery and acid juices being in a great measure dissipated, they become less disposed to ferment in the stomach, and are, in general, safer than in a crude state.

2571. *With respect to the chemical analysis of fruits*, the small progress that has been made in the very difficult branch of vegetable chemistry precludes the possibility of giving the composition of all of them, very few having been subjected to rigid investigation. Many of them contain peculiar principles, and, in general, their composition is complicated. The usual principles in fruits are water, sugar, bitartrate of potash and of lime, malic acid, acetic acid, citric acid, binoxalate of potash, vegetable mucilage or extractive matter, tannin, the principle of flavour, and the colouring principle. The sugar of fruits is generally of the uncrystallizable kinds. The acids are chiefly the malic, acetic, and citric. In a few these are found free, but are most frequently combined with lime or potash. Malic acid is found in apples, currents, gooseberries, strawberries, raspberries, elderberries, and plums. Several acids are frequently found in one fruit.

SECT. II.—KERNEL FRUITS.

2572. These, *called also pomes*, from the Latin word signifying apple, have a pulp rather firm, so as to be termed fleshy by botanists, and they have their seeds not loose in the pulp, nor enclosed in a hard shell, but contained in cells formed of tough membranes.

SUBSECT. 1.—*Apple* (*Pyrus Malus*, Linn.).

2573. *No fruit in Britain is so abundant, and so generally useful, as the apple*, and none can be brought to such high perfection with so little trouble. It is employed at the dessert, in the kitchen, and for making cider. It is important from its hardiness and excellent flavour; and it has this striking advantage over all our other fruits, that it remains longest in season, and may be preserved with ease through the winter; whereas our stone fruits can only be kept in their natural state for a few days, and require extraordinary means to preserve them.

2574. *Homer describes the apple as one of the precious fruits of his time*, and it was cultivated and highly esteemed among the Romans, who brought it from the East, and set an extraordinary price upon fine bearing trees. The best varieties are natives of Asia, and

have been introduced into Europe by grafting upon others. The only variety indigenous to Britain is the austere crab-apple of our hedges; but the cultivated kinds were introduced at an early period. During the Saxon heptarchy, Somersetshire and Devonshire were called the apple country, and there were large plantations near Glastonbury. Some apple-trees in Herefordshire now existing are said to be a thousand years old, and many varieties were undoubtedly brought over by the Normans in the time of William the Conqueror. The varieties of the apple have been prodigiously increased in this country, this fruit having a peculiar tendency to change by circumstances connected with its cultivation. Parkinson, in 1629, enumerates fifty-seven sorts. Evelyn, about thirty years afterward, states that "it was through the plain industry of one Harris, a fruiterer to Henry VIII., that the fields and environs of about thirty towns in Kent only were planted with fruit from Flanders, to the universal benefit and general improvement of the county." Hartlet, in 1650, speaks of "one who had 200 sorts of apples," and "verily believes there are nearly 500 sorts in this island." Since that time there has been a continual accession of sorts received from the Continent, as well as numerous varieties raised from seeds. The last catalogue of fruits, published by the Horticultural Society of London in 1831, enumerates 1400 sorts of apples, and those which have been acquired since that time would extend the list to 1500. Of no other fruits are there so many excellent varieties in general cultivation, suited to almost every soil which our island affords. Some sorts are ripe in the beginning of July; others ripen much later: those which ripen latest are the best.

2575. *Apple-trees will not grow in tropical countries*, but, like the oak, extend from the tropics to the latitude of 60°, and are not to be found in Lapland. The apple is, therefore, the growth of temperate and rather cold climates only.

It has been supposed, and the opinion was supported by Mr. Knight, that many of the oldest varieties of apples known to our ancestors are worn out, and others are now in a state of debility; thus the celebrated golden pippin, which was formerly the common cider apple of the Hereford orchards, is now preserved with difficulty in our gardens. This opinion, however, has been controverted.

Apples are divided into those which, from sweetness, are fit for eating, called *eating*, or *table apples*; those which are proper for pies, tarts, &c., termed *kitchen* or *baking* apples; and those for making cider, or *cider* apples. The best baking apples are the Colvilles, for early use; the rennets and pearmains, for autumn; the russets, and Padley's pippins, for winter and spring. For dessert apples, Margarets, for early use; Pomeroy, summer pearmain, and Kentish codlin, for summer use; golden, Dowton, and other pippins, especially the ribstone, with the nonpareil, and other small russets, for autumn, winter, and spring. Some apples are not eatable until kept some time.

2576. *All apples contain* sugar, malic acid, or the acid of apples, mucilage or gum, woody fibre, and water, together with some aroma, on which their peculiar flavour depends; and their different qualities may be traced to the different proportions of their principles. The hard, acid kinds are unwholesome if eaten raw; but by the process of cooking, a great deal of this acid is decomposed, and converted into sugar. The sweet and mellow kinds form a valuable addition to the dessert, and they are employed in the composition of marmalades, jellies, &c.; and from the juice is prepared a drink useful in fevers. A great part of the acid juice of the apple is converted into sugar as the fruit ripens, and even after it is gathered, by a natural process termed maturation, an account of which is given in the article "Preservation of Fruit." On the contrary, when apples decay, the sugar is changed into a bitter principle, and the mucilage becomes mouldy and offensive.

As in apples more than half consists of water, and as the rest of the ingredients are not of the most nutritive kind, this fruit cannot rank high as food; it is chiefly useful as an agreeable acid-sweet summer fruit. When cooked it is considered as slightly laxative, and therefore a useful adjunct to other food: this is probably the origin of apple sauce, so common with pork, ducks, and goose. The raw fruit is not advisable for dyspeptic persons. Old cheese has a remarkable effect in meliorating them when eaten; probably from the volatile alkali or ammonia of the cheese neutralizing their acid.

SUBSECT. 2.—*Pear (Pyrus Communis, Linn.).*

2577. The pear, like the apple, is indigenous to this country; but the wild pear is a very austere fruit. The best varieties were brought from the East by the Romans, who cultivated them with care, and probably introduced some of their best sorts into this island, to which others were added by the inhabitants of monasteries. The Dutch and Flemings, as well as the French, have excelled in the cultivation of the pear, and most of the late varieties introduced by the Horticultural Society are from France and Flanders.

The pear is a hardy tree, and a longer liver even than the apple; in a dry soil it exists for centuries. It will grow in almost any soil, and flourishes perfectly in our hedges.

2578. *Eating pears* were formerly divided into two sorts, viz., *proud pears*, which would not keep, and *woodens*, so called from their property of keeping. Pears, how-

ever, have been wonderfully improved as a table fruit within the last twenty or thirty years, through French and Flemish botanists and horticulturists, by whose experiments our own gardeners have largely profited. The best sorts are delicious, and are preferred to the apple at the dessert. They should have a rich aromatic flavour, and be either of the melting kind (*buerré*, butter pears), or be firm and crisp, like the winter bergamots.

2579. *Above* 150 *varieties of pears are enumerated in late catalogues*, all differing from each other in their qualities, time of ripening, &c. For summer pears, some of the best are the Muscadelle, Windsor, Jargonelle, Bonchrétein, &c. For winter, the St. Germain, Wilding, Rousselet, Bergamot, &c. For the kitchen, the Swan's Egg, Spanish red wooden, black Worcester, &c. Perhaps one of the most delicious sorts in Europe is that known throughout the north of Spain as the Pera de Mantiga, or "Butter Pear," and some of a very superior kind are grown in Guernsey and Jersey. The species grown in the neighbourhood of Guimaræns, in the north of Portugal, is equally celebrated.

2580. *Though perfectly wholesome when ripe, the pear is not so when green;* but in this state it is fit for stewing. The best kitchen pears for baking are rather austere than sweet: cooking converts part of the acid into sugar. They may be preserved in the same way as apples; but they are also pared and dried in an oven, by which means they will keep for years: this mode is much practised in France.

This fruit is likewise much employed for making perry, and the most austere varieties, unfit for eating, are best for this purpose. A mixture of the wild pear with the cultivated sort is thought to make peculiarly fine liquor.

2581. We do not find any good analysis of the pear, but it is evidently not very different in its composition from the apple, in some varieties containing more sugar.

SUBSECT. 3.—*Quince* (*Pyrus Cidonia*, Linn.).

2582. This tree is classed by botanists with the apple and pear, and the latter are generally grafted on quince stocks, proving their consanguinity. It is a native of Austria, and grows wild on the banks of the Danube. It is said to have been introduced here from the Isle of Candia, and grows easily in our hedges, but is not much used, the fruit, in its raw state, having a peculiar disagreeable smell and an austere taste. It is sometimes employed to give a flavour to apples in pies and tarts, and is occasionally made into a marmalade, which is much used in the south of France, where the quince is extensively cultivated. The juice, as a medicine, is cooling, astringent, and stomachic.

SUBSECT. 4.—*Medlar* (*Mespilus Germanica*, Linn.).

2583. This fruit, a native of the south of Europe, but long naturalized, somewhat resembles a small apple, and has a good deal of flavour, but which is seldom developed, even in its ripe state, on the tree. It is gathered and laid by till it begins to change or grow rotten, when only it is fit to be eaten.

SECT. III.—STONE FRUITS.

2584. *Stone fruits are such as have their seeds enclosed in a hard nut or shell, and this covered by a fleshy pulp.* Those which are known among us belong to the natural order of *amygdaleæ*, and consist of the peach, nectarine, apricot, plum, and cherry. All these contain certain principles in their kernels, from which Prussic acid is developed by the action of water, though this acid does not exist in them ready formed. Some species of this tribe in other countries are highly poisonous: the Cerasus capricida kills the goats of Nepal which happen to eat them; and the Cerasus Virginia of North America is known to be dangerous. Notwithstanding, however, this poisoneus principle in the kernels, the pulp of our fruits of this kind are perfectly harmless.

SUBSECT. 1.—*Peach and Nectarine* (*Amygdalus Persica*, Linn.).

2585. These, which are among the most delicious of our fruits, are considered as varieties of the same species produced by cultivation. The latter is characterized by a very delicate down, while the former is smooth; but as a proof of their identity as to species, trees have born peaches in one part and nectarines in another; and even a single fruit has had down on one side, and the other smooth. The trees are almost exactly alike, as well as the blossoms.

2586. Pliny states that the peach was originally brought from Persia, where it grows naturally, from which the name of Persica was bestowed upon it by the Romans; and some modern botanists apply this as the generic name, separating them from the Amygdalus, or almond, to which Linnæus had united them.

2587. Although they are not tropical, they require a great deal of warmth to bring them to perfection; hence they seldom ripen in this country in ordinary seasons without the use of walls or glass; consequently, they bear a high price.

2588. In a good peach, the flesh is firm, the skin thin, of a deep bright colour next the sun, and of a yellowish green next to the wall: the pulp is yellowish, full of highly

flavoured juice, the fleshy part thick, and the stone small. Too much down is a sign of inferior quality. This fruit is much used at the dessert, and makes a delicious preserve.

2589. Both the peach and the nectarine are separated into, 1, the *free-stone*, or *melting peaches*, those in which the pulp or flesh separates easily from the stone; and, 2, the *cling-stone varieties*, in which the flesh clings or adheres to the stone; the first are generally the best flavoured. There are above two hundred varieties enumerated in the catalogue of the Horticultural Society.

2590. Peaches are often cultivated in large quantities. At Montreuil, a village near Paris, almost the whole population is employed in the growing of peaches, which has maintained the inhabitants for ages; and the consequence is, that they raise better peaches there than in any other parts of France. The best in Europe are Italian. In Maryland and Virginia, peaches grow nearly wild in extensive plantations or orchards resembling forests, but the fruit is of little value for the table, being employed only in fattening hogs, and for the distillation of peach brandy. On the east side of the Andes, peaches grow wild among the cornfields, and in the mountains, and are dried as an article of food.

2591. The young leaves of the peach are sometimes used in cookery from their agreeable flavour; and a liqueur resembling the fine noyeau of Martinique may be made by steeping them in brandy sweetened with sugar and fined with milk: gin may also be flavoured in a similar manner. The kernels of the fruit have the same flavour.

2592. *The nectarine is said to have received its name* from nectar, the particular drink of the gods. Though it is considered as the same species as the peach, it is not known which of the varieties came from the other: the nectarine is by some considered as the superior fruit.

Subsect. 2.—*Almond* (*Amygdalus*).

2593. *The almond-tree is a native* of warmer climates than Britain, and is indigenous to the northern parts of Africa and Asia; but it is now commonly cultivated in Italy, Spain, and the south of France. It is not usually grown in Britain, and the fruit seldom ripens in this country; it is much admired for the beauty of its blossoms. It strongly resembles the peach tree in the form of its leaves and blossoms, and is included in the same genus by botanists; but the fruit, instead of presenting a delicious pulp like the peach, shrivels up as it ripens, and becomes only a tough coriaceous covering to the stone enclosing the eatable kernel, which is surrounded by a thin bitter skin. It flowers early in the spring, and produces fruit in August.

2594. *There are two sorts of almonds, sweet and bitter*, but they are considered to be only varieties of the species; and though the qualities of the kernels are very different, they are not distinguishable by their appearance.

2595. *The sweet almond* (*A. communis*, Linn.) is much used at the dessert and in confectionery. The Valentia almond is sweet, large, and flat-pointed at one extremity, and compressed in the middle. The Italian almonds are not so sweet, smaller, and less depressed in the middle. The Syrian or Jordan almonds come from Malaga, and are the best sweet almonds brought to England. They are longer, flatter, less pointed at one end, and less round at the other, and have a paler cuticle than those just mentioned. Almonds are not considered to be very digestible. The brown skin easily comes off by pressing with the fingers when they are put into boiling water: they are then dried till they are brittle, and the interior part being white, they are then said to be *blanched*. This skin, or pellicle, sometimes disagrees with the stomach, and, on that account, almonds, when brought on the table as dessert, ought to be blanched.

2596. *When analyzed*, 91 parts of sweet almonds are found to consist of 54 parts of fixed oil, 3 of gum, 24 vegetable albumen, 6 saccharine matter, 4 woody fibre, 3 of water, and a trace of acetic acid.

2597. *The bitter almond* (*A. amarus*, Linn.) has, like the sweet, no smell when entire; but when bruised in a mortar it has the odour of the peach-blossom, and the taste is the pleasant one of the peach kernel, a property which occasions its use in flavouring many preparations.

2598. *Though bitter almonds do not contain prussic acid ready formed*, they contain two principles, amygdalin and emulsin, which, when acting on each other by means of water during distillation, produce prussic acid and a volatile oil, both violent poisons; and when bitter almonds are chewed, the moisture of the mouth and the emulsin of the seeds effect the decomposition of the amygdalin, and the consequent formation of prussic acid and volatile oil. Though the proportion of these poisons in a few of the almonds does not prove fatal, yet, when almonds have been eaten in large quantities, serious, and even fatal consequences, have been the result.

2599. *The volatile oil of bitter almonds* is sold in some shops under the name of *essence of bitter almonds*; and this is a most potent poison, being in general four times as powerful as the prussic acid kept in chemist's shops. A single drop of it will kill a cat in a few minutes. This preparation is sold to dealers in cordials, to make what they call "genuine noyeau," and it is used by some confectioners to flavour their preparations; but it is evident that so dangerous a substance should not be trusted in the hands of persons not thoroughly acquainted with its deleterious effects. See "Prussic Acid," Book VII., Chap. VII., Sect. 16.

2600. *Almonds contain a large proportion of fixed oil*, which is obtained by expression; this is mild and wholesome, and is much used in medicine as a pure oil. When almonds and water, with a little sugar, are triturated together in a mortar, a white liquor results, which is considered to be very nearly similar to animal milk, and is called *milk of almonds*; it is curdled by acids. Cream even separates from this milk, which may be converted into a species of butter. Several substances not mixible of themselves with water may, by trituration with almonds, be mixed with it, and thus fitted for medicinal use; such mixtures are called *emulsions*. Almond oil is used for making fine soap; and the almond cake, after pressing out the oil, is employed as a cosmetic.

Both sweet and bitter almonds contain the bland fixed oil obtained by expression, but it is chiefly procured from bitter almonds, which, after being blanched, are submitted to great pressure between two hot iron plates; the matter which remains, or the almond cake, is the source of the prussic acid, which is obtained by a subsequent process. When the cake is moistened with boiling water, the odour of the volatile oil, and of prussic acid, is immediately perceived.

2601. *The importation of almonds* into England amounts annually to about six hundred tons, of which about ninety-five are Jordan, the rest chiefly from Barbary and Spain. Bitter almonds come chiefly from Magadore.

SUBSECT. 3.—*Apricot* (*Prunus Armeniaca*, Linn.).

2602. *The genus Prunus includes the apricot, plum*, and *sloe*. The apricot was cultivated by the Romans, and is stated by Pliny to have been brought from Armenia, where it is found abundantly on the slopes of the mountains. Vast quantities grow in the oases of Africa, and are carried in a dried state to Egypt. It is the opinion of Mr. Royle, author of the "Botany of the Himalaya," that the Cabul Mountains are the source of the apricot, as well as many others of our fruit-trees. He states that the apricot grows wild at present in the hills between the Ganges and Jumna, as well as in Cashmere, together with the peach, nectarine, walnut, almond, plum, cherry, and also the apple, pear, quince, and pomegranate. It is also planted very abundantly round the villages, the fruit being eaten both fresh and dried, while a fine oil is expressed from the kernels. It is likewise plentiful in China and Japan.

2603. In the climate of England it is of less importance than many other fruits; its blossoms, in early seasons, are very subject to the effect of spring frosts, which renders its crops precarious. It is, however, much cultivated, and is used at the dessert, though inferior to the peach. The young fruit makes an excellent tart and preserve or jam, which is the use to which the apricot is best suited, possessing a moderate degree of acidity with a rich saccharine quality. The apricots produced upon standards, which are the best, do not appear north of Ipswich, and several of the sorts known in the south of Europe are too tender for England. It was first brought to this country by the gardener of Henry VIII.

SUBSECT. 4.—*Plum* (*Prunus Domestica*, Linn.).

2604. *The wild sloe is considered by Mr. Knight as the parent of the plum*, but the acclimated kinds come from the East. The cultivation of this fruit was probably attended to very early in England, as Gerard informs us that in 1597 he had in his garden in Holborn three score sorts.

2605. *The damson*, or Damascene plum, takes its name from Damascus, where it grows in great quantities, and from whence it was brought into Italy about 114 years B.C. The *Orleans plum* is from France. The *green gage* is called after the Gage family, who first brought it to England from the monastery of the Chartreuse, at Paris, where it still bears the name of *Reine Claude*. The *magnum bonum* is our largest plum, and greatly esteemed for preserves and culinary purposes. The best sorts of plums are agreeable at the dessert, and, when perfectly ripe, are wholesome; but some are too astringent. They lose much of their bad qualities by baking; and are extensively used, from their cheapness, in tarts and preserves, but they are not a very wholesome fruit, and should be eaten in moderation.

Dried plums are called prunes, of which several kinds are met with in the shops, and used at the dessert: the Brignolle plums, brought from Brignolle, in Provence, which is of a reddish-yellow colour, and has a grateful, sweet sub-acid taste; the common French prune, and the Damascene plum. Others come from the banks of the Rhine, by way of Holland, and others, again, are brought from Portugal. The *common medicinal prune* comes chiefly from Bordeaux.

2606. *The sloe* is a shrub common in our hedgerows, and belongs to the natural order Amygdaleæ. The fruit is about the size of a large pea, of a black colour, and covered with a bloom of a bright blue; it is one of the few indigenous to our island. The juice is extremely sharp and astringent, and was formerly employed as a medicine, where an astringent was necessary; it is employed in the manufacture of a red wine made to imitate port, and also for adulteration. The leaves have been employed to sophisticate tea. The fruit, when ripe, makes a good preserve.

2607. *The bird cherry* (*Prunus Padus*, Linn.) is a fruit little known, and nauseous to

most palates, but when infused in gin or whiskey, it greatly improves those spirits, and the infusion is only surpassed by that of peach leaves.

SUBSECT. 5.—*Cherry* (*Cerasus Duracina*, Linn.).

2608. It is a question whether this beautiful fruit be indigenous in Britain. It is generally stated that the cherry was brought to Italy by the Roman general Lucullus from a town in Asia called Cerasus, and that we owe it to the Romans. This may be true of some varieties, but the cherry appears to be a native of most temperate countries of the northern hemisphere, and a small black wild cherry is found in Herefordshire, and even in the mountains of Scotland; this, when cultivated in Aberdeenshire, where it is known by the name of *Geans*, is a delicious fruit. At some of the ruins of our abbeys and baronial castles there are still existing some of these black cherry-trees that have attained the height of sixty or eighty feet, and which now produce vast quantities of fruit. All agree that the cherry has been a favourite fruit in England, and in general cultivation ever since the time of Henry VIII., when it was planted in Kent, where cherry orchards were formerly very extensive, and are still celebrated; but this fruit was probably introduced here at a much earlier period, for it is ascertained that in the fifteenth century it was hawked about the streets of London in the same manner as at present.

2609. *About two hundred varieties of cherries are enumerated*, some of which are in season, from the Kentish and May duke at the beginning of autumn, to the yellow Spanish and Morillo late in the winter. When perfectly ripe they are refreshing, and are excellent for pies and tarts. *A wine is made from the juice* resembling red Constantia. *A spirit is also distilled* on the Continent from the pulp fermented, called *Kirschenwasser*. The liquor called *cherry brandy* is made by putting the best black varieties into brandy. *Noyeau* is a liquor flavoured by the kernels of the variety *Cerasus occidentalis*; and a large black cherry is employed in the *ratafia* of Grenoble. The *maraschino* of Zara is made from a particular species cultivated in Dalmatia.

2610. *The cherry is, by some botanists, included in the same genus as the plum* (*Prunus*), and, like all this class of stone fruits, contains in its leaves and kernels some of the principles which are the source of the agreeable flavour resembling that of the peach-blossom. The poisonous liquid called *laurel water* is made by distilling the leaves of the *bird cherry*; those of the *Lauro-cerasus*, or cherry-laurel, as well as some other cherry leaves, afford a similar liquid, although the fruits are not poisonous.

SUBSECT. 6.—*Olive* (*Olea Europea*, Linn.).

2611. The olive-tree is interesting from historical recollections. It was the leaf of this tree, brought into the ark by the dove, that gave the first evidence of the waters of the deluge having abated, since which time it has been employed as an emblem of peace. The olive was sacred to Minerva; it frequently appears in Grecian sculpture, and a wreath made of the leaves was a reward bestowed in the games of Athens. The mention in Scripture of the Mount of Olives near to Jerusalem proves it to have been a favourite tree in Palestine; and it is an interesting fact that wild olives still exist upon the spot. The olive is indigenous in Syria, Greece, and the north of Africa; and the beautiful plain of Athens seems almost covered with them.

2612. *The cultivated olive* (*fig.* 512) was introduced into Italy by the Romans: it now grows there in great abundance, as likewise in Spain and the south of France, but the fruit will not ripen in countries farther to the north. It will grow in England, but though an evergreen in warmer climates, with us it loses its leaves in winter, and the fruit does not ripen in the open air.

2613. *The fruit* is smooth and oval, about three quarters of an inch in length, and half an inch in diameter, being about the size of a small plum. When ripe it is of a deep violet colour, whitish and fleshy within; it is rather bitter, and to many nauseous, but has its pulp replete with a bland oil, and with an oblong, pointed, rough nut in the interior. In Greece, and also in Portugal, the fruit is eaten in its ripe state, but its taste is not agreeable. They are prepared for food in two ways: one is simply to cut and soak them in salt and water, adding a few herbs to give them a flavour; the other is to dry them in the sun, whereby they become black; they are then put into jars, with oil, salt, and pepper, or other spices, adding also a few herbs. When eaten, they are invariably flavoured with oil and a little vinegar. The Italian shepherd often takes nothing to the field with him but a little bread, a flask of wine, and a horn of olives; indeed, bread and olives form a nutritive diet.

Fashion has done much in this country to introduce and create an acquired taste for green pickled olives at the dessert. They are chiefly taken with a view to remove the taste of the viands from the mouth, previously to enjoying the flavour of wine.

Three kinds of olives come to London, Italian, French, and Spanish. The former are the best, and are from Lucca; the French are from Provence, and are also excellent; the Spanish are larger, but more bitter.

2614. *Olives are pickled in the following manner:* being gathered before they are ripe, they are suffered to steep in water for some days, and afterward are put into a lye of water and barilla, with the ashes of olive stones calcined, or with lime; and after remaining there a sufficient time, are bottled or barrelled with salt and water. They are thought to promote digestion and give appetite.

2615. *But olives are chiefly cultivated for the oil which they produce*, and which, in the countries where they grow, forms as necessary an article in the culinary art as butter with us. Olive oil, called also *salad oil*, is also largely used in Britain for the more delicate parts of our cookery, instead of butter, and is a useful addition to salads, preventing them from running into fermentation and producing flatulency. When the fruit is ripe, it is put into a bag of rushes, and the oil is forced out by gentle pressure. The first affords the virgin or best oil; a second quality is procured by a pressure sufficient to break the kernels. After the oil has been drawn, it deposites mucilage, and, when sufficiently clear, it is put into clean flasks, as we receive it. The greatest part of our best oil comes from Italy, and is known by the name of Florence, Lucca, and Gallipoli oil. Some is also brought from Spain and the Grecian islands. When quite fresh and pure, it has very little taste or smell, and is quite transparent, having only a pale greenish tint. It is sometimes adulterated with poppy oil.

Sect. IV.—Orange Tribe.

2616. To the orange tribe or genus (*Citrus*) belong the *sweet orange*, the *Seville*, or *bitter orange*, the *lemon*, the *citron*, the *lime*, and the *shaddock*. They are all remarkable for containing much *citric acid* in their juice, and a very odoriferous and inflammable, acrid, essential oil in their outer rind. Besides these principles, they also contain the malic acid, and more or less of the saccharine and bitter principles. In the orange the sugar is prevalent, but in the Seville orange the bitter principle prevails.

The acid varieties are much used in medicine, and in the manufacture of cooling drinks; the sweet varieties are esteemed for the dessert, and the bitter as stomachics. The rind affords the essential oil of lemon and bergamot; and from the flowers a fragrant aromatic water is distilled. The unripe, or abortive fruits, called Curaçoa oranges, are used to flavour the delicious liqueur called *Curaçoa*. They are natives of the warmer parts of Asia, though they have been long introduced into the West Indies, the tropical parts of America, the Atlantic isles, and the warmer parts of Europe.

Subsect. 1.—*Sweet Orange* (*Citrus Aurantium*).

2617. This very useful and agreeable fruit gives us a striking instance of the advantages of commerce. Although the production only of countries much warmer than our own, we enjoy it nearly at the price of our ordinary fruits; and this is the more important, since it is perhaps the most refreshing and healthy of all fruits of warm countries. It is calculated that about 27,000,000 oranges are annually imported into England, and they are brought without any preparation farther than wrapping each separately in paper, and packing them in boxes.

Most of the oranges and lemons intended for exportation are gathered before they are quite ripe, for if they were mature, they would spoil in the carriage. The gathering of them for the British market usually occupies from the beginning of October to the end of December. They are not ripe till the spring. Though the name of China is attached to it, it is doubtful whether it was originally a Chinese fruit; and it has been supposed by some classical commentators that the golden apples of the Hesperides were the orange.

2618. *The best come from St. Michael's*, in the Azores, where they were introduced by the Portuguese; but very good ones are brought from Portugal, Spain, and Malta: some also grow in the south of France and Italy, but they are inferior.

The orange-tree may be mentioned as an instance of extraordinary fecundity: a single tree at St. Michael's has been known to bear in a season 20,000 oranges fit for packing, exclusive of those damaged and wasted, amounting to at least one third more. The delightful perfume of an orange-grove is such as to scent the air for miles; and the tree gives a succession of flowers during the whole summer.

Magnificent conservatories have been erected for them in countries where they do not bear the cold of winter. The first orange-trees were brought to England by Sir Walter Raleigh. At Hampton Court there are some said to be 300 years old; these, and also some at Windsor, are kept in green-houses during the winter, and are wheeled into the open air about the middle of June, when the perfume of their flowers is delicious. In point of age, these are far surpassed by those at Cordova, in Spain, the seat of ancient Moorish grandeur: some trees there are said to be six or seven hundred years old. In Devonshire and in other parts of England they have produced fine fruit when trained against walls and sheltered with mats. At Mr. Pugh's villa, at Rouen, there is

a collection of a hundred orange-trees in boxes above seventeen feet high, and several centuries old; in winter they are kept under cover. In 1823 these produced 1400 lbs. of blossoms, which sell, on an average of years, at 2*s*. 4*d*. per pound, for the purpose of making orange-flower water.

2619. *The agreeable sub-acid of the orange* renders it one of the most agreeable, cooling, and wholesome of fruits; and the essential oil in the rind is serviceable to the cook in giving flavour to many dishes.

2620. *The varieties of the orange are numerous*; but the most important, as enumerated by Professor Burnett, are, 1, the common sweet orange; 2, the China; 3, the Majorca; 4, the Nice; 5, the Genoa; 6, the thick-rinded Portugal; 7, the tea-fruited; 8, the double-flowered; 9, the ribbed; 10, Malta, or blood-juiced; 11, the St. Michael's; and, 12, the Oporto, or pipless pot oranges.

2621. *It is observed in the Library of Entertaining Knowledge*: "The extraordinary consumption of a production which is brought here from very distant places is a natural consequence of certain qualities which fit the orange, in a remarkable degree, for being the universal fruit of commerce. If we would have foreign figs and grapes, they must be dried, for the undried grapes, which we bring even from the short distance of Portugal, are flat and vapid; the tamarind is a liquid preserve; the guava must be made into a jelly; the mango destined for us requires to be pulled before it is ripe, and is pickled; the date must be dried; and the cocoanut becomes, when here, consolidated and indigestible. With regard to the orange, man may have it fresh in every region of the world, and at almost every season of the year. The aromatic oil and the rind preserve it from the effects both of heat and cold; and the acridity of the former renders it proof against the attacks of insects. It is true that oranges rot, like other fruits; but that does not happen for a long time, if the rind is uninjured and they are kept from moisture, and so ventilated as not to ferment."

SUBSECT. 2.—*Seville Orange* (*Citrus Vulgaris*).

2622. This variety, called also the *bitter orange*, is of the same species as the sweet orange, and grows in great abundance on the banks of the Guadalquivir in Andalusia, from which they are chiefly obtained. In that part of Spain there are very extensive orchards of these oranges, which form the chief wealth of the monasteries. The pulp of the bitter orange is not eaten raw; in the yellow rind, separated from the white, spongy substance immediately below it, there is contained an essential oil, which is an agreeable warm aromatic, much superior for many purposes to that of the common orange. The best marmalade and the richest wine are made from this orange, and it is from the flowers of this that the best orange-flower water is distilled. They are also preserved whole as a sweetmeat.

SUBSECT. 3.—*Lemon* (*Citrus Limonum*).

2623. The lemon or citron tribe are natives of Asia, and appear to have been well known to the Romans: they are mentioned by Virgil and Pliny, but only as foreign fruit, and as antidotes against poison. It does not appear that they cultivated them. The citron is found wild in that part of India which is beyond the Ganges; also in Assyria and Persia, and was brought into Europe by the Arabians. It is now abundant in the south of France, Italy, Spain, and the West Indies.

The lemon is hardier than the orange. In some parts of Devonshire lemon-trees are trained to the walls, and require no more than a covering of straw or mats during the winter. Earl Paulet presented some of these lemons to George III. upward of fifty years ago, which grew in the garden of his sister, Lady Bridget Buttord. They were first cultivated in this country in the reign of James I., and are now not uncommon in our green-houses.

2624. The fruit in common use, however, is imported from Spain, Portugal, and the Azores, packed in paper, in the same manner as oranges. The Spanish are the most esteemed; those of St. Helena are extremely fine, growing larger and milder than the others. This fruit is not an article of mere luxury, but is almost an essential for culinary and many other purposes. The juice consists chiefly of the *citric acid*, which, besides its agreeable flavour, is particularly cooling and grateful. But the discovery of its antiscorbutic influence gives it a still higher value.

2625. *The scurvy, formerly so fatal in ships* making long voyages, is now *almost wholly unknown* in them: a result that is, in a great measure, to be attributed to the *regular allowance of lemon juice* served out to the men. The juice may be preserved in bottles for a considerable time by covering it with a thin stratum of oil; thus secured, great quantities of it are exported from Italy and Turkey to various parts of the world; it is also frequently administered as a medicine, and is extensively employed in the manufacture of punch. The citric acid is also prepared in a pure state, and crystallized, by which means it can be preserved in any climate, and for any length of time; but it is found that the crystallized acid is inferior to the recent juice. *Shrub* is made of lemon juice, sugar, and rum.

2626. *The outward rind or peel of the lemon contains* a highly odoriferous essential oil, and on that account it is a valuable and agreeable stomachic, and is used for flavouring a variety of dishes; it is warm, aromatic, and slightly bitter: it is also made into an excellent sweetmeat when cleared of the pulp and preserved by sugar, well known by the name of *candied lemon peel*. A liqueur is made by the inhabitants of Barbadoes from lemon peel, in a manner peculiar to themselves, called *Eau de Barbade*.

Subsect. 4.—*Citron* (*Citrus Medica*, Linn.).

Fig. 513.

2627. This fruit (*fig.* 513) belongs to the same species as the lemon, being considered only as a variety, the distinction between them not being very great. It is larger and less succulent, but more acid; with a little artificial heat the citron comes to as great perfection in England as in Spain and Italy. The fruit is oblong, and about five or six inches in length. The tree is thorny. The juice forms an excellent lemonade with sugar and water. Its uses in punch, negus, and in medicine, are well known. The rind is very thick, and, when candied with sugar, forms an excellent sweetmeat. There are several varieties cultivated in England, one of which is termed the *forbidden fruit*.

Subsect. 5.—*Shaddock* (*Citrus Decumana*).

2628. This is also a variety of the same species as the lemon and orange. It is much larger than these, the fruit being from three to six inches in diameter. Though a native of China, it is cultivated largely in the West Indies, where it was first carried by Captain Shaddock. In its native country it is a sweet fruit, with little acidity; but in the West Indies, through neglect in its cultivation, it has degenerated into a sour fruit. It is handsome, and contains abundance of juice, which, diluted, is used as a beverage, and in making punch. Though less agreeable in its flavour than the orange, it keeps fresh and good longer at sea: hence it is valuable.

Fig. 514.

Subsect. 6.—*Lime* (*Citrus Acida*, Rox.).

2629. This (*fig.* 514) is also a variety of the lemon, but much smaller, being only about an inch or an inch and a half in diameter. It is not much cultivated in Europe, but, being more acid and cooling than the lemon, it is a great favourite in the West Indies, where lime punch is more esteemed than any other. The greatest part of our citric acid is prepared from its juice. There are several varieties.

Sect. V.—PULPY FRUITS.

2630. These have their seeds lying among the pulp, and are not enclosed in a nut or membrane like the grape.

Subsect. 1.—*Pineapple* (*Bromelia Ananas*, Linn.).

2631. It is the gardener's boast that this delicious fruit is produced in every part of Britain, by the employment of artificial heat, in greater perfection, both as to size and flavour, than in the West Indies, where the climate is natural to them. It grows wild in vast abundance in many parts of Africa and South America, and is cultivated in the hotter islands of the West Indies, where it requires but little attention to procure this elegant fruit in perfection and plenty. In Jamaica, pineapples have become so prolific that they are often used to flavour rum, and a wine is made from the fermented juice of the sweeter sorts nearly equal to malmsey.

2632. It has not been known in Europe above two hundred years, and has not been cultivated in England much above a century. It is stated that the first pine-apples raised in Europe were by M. la Cour, of Leyden, about the middle of the seventeenth century, and it is said to have been first cultivated in England by Sir Matthew Decker, of Richmond. In Kensington Palace there is a picture in which Charles II. is represented as receiving a pineapple from his gardener, Rose, who is presenting it on his knees.

2633. *At present, pineapples may be procured* any day of the year in London with more certainty than in their native countries, and of late their price has been very much reduced. It derives its name, probably, from the resemblance which the form of the fruit bears to that of the cone of the pine. This fruit is formed of many clustered tubercles, supporting crimson flowers; on the summit stands a crown of clustered leaves. While the fruit is growing, spines shoot out on all sides; but as it approaches maturity, these become dry and soft. It should be cut a little before it is quite ripe, and kept a few days. The largest pineapple ever grown in this kingdom was cut lately from the hot-house of John Edwards, Esq., of Rheda, Glamorganshire, and was presented to the king at Windsor. It weighed 14 lbs. 12 oz. avoirdupois, was 12½ inches high, exclusive of the crown, and 26 inches in circumference. It is the first of dessert fruits, and is, likewise, preserved in sugar, and made into marmalade. The malic and citric acids, which give to the juices, when fully ripe, their exquisite flavour, are abundant before maturity; the unripe juice is said even to have caustic properties, and at all times is so powerful as to corrode the knives with which the fruit is cut. In England, after the crown has been twisted off, the fruit is cut in horizontal slices; but in the West Indies it is cut obliquely, in the direction of the pips.

SUBJECT. 2.—*Grape* (*Vitis Vinifera*, Linn.).

2634. Next to the pineapple, grapes, when in perfection, have always been considered the most delicious fruit for the dessert.

2635. *The early history of the vine* is involved in the same obscurity as that of most of our vegetable productions. Its antiquity is unknown; but from the Scriptures we learn that its cultivation was of very early date. Bacchus was imagined to have taught its use in making wine, and was, in consequence, elevated to the rank of a god. Humboldt says that the vine now cultivated in Europe grows wild on the banks of the Caspian Sea, and in Armenia, which countries and Persia are probably its native place. From Asia it passed into Greece and Egypt, and thence into Italy and the rest of Europe. The Romans planted it on the banks of the Rhine; and France, now so remarkable for the excellence of its grapes, possessed none in the time of Strabo. It appears to have been brought into England towards the close of the Roman power, and in the time of the Anglo-Saxons it was cultivated in several parts of England; afterward, while the monasteries existed, few of them were without their vineyard.

It is a curious and interesting fact, which we shall enlarge upon in our account of wines, that in ancient times large quantities of wine were annually made in Britain. This has been supposed by some to indicate a change in our climate, an opinion, however, which is not sufficiently supported.

2636. *The grape vine has a limited range of latitude*, extending from the twenty-first to the fiftieth degree of N. latitude. Some varieties of it are found wild in America, particularly on the banks of the Ohio, where the French settlers have made tolerable wine from it. It is also cultivated in the same situation in the southern hemisphere, in South America, the Cape of Good Hope, and Australia.

2637. *Abundance of grapes ripen against walls in England* at present, but the best sorts are raised in vineries and hot-houses; the former are so common that there is scarcely a kitchen-garden worth notice without one; and, with the improvements of modern gardening, our hot-house grapes are not inferior in flavour to any produced in any part of the world.

2638. *The luxuriance and size of the vine in warm climates* is so great that it would scarcely be credited here, were it not well authenticated. Strabo relates that some bunches of grapes in Italy were a yard across. Bunches have been grown in Syria forty pounds in weight, but these are of a distinct species of grape. In England the bunches are usually from two to seven pounds, but they have been known to reach nineteen pounds.

The great vine at Hampton Court, planted in 1769, of the variety called black Hamburgh, occupies a space of 116 square yards, and has a stem thirteen inches in circumference; one branch is 114 feet long; it is a most productive bearer, having seldom fewer than 2000 bunches upon it every season, each weighing a pound on an average, or in all nearly a ton. Its parent, still existing in Valentine House in Essex, planted in 1758, is still larger, and nearly as productive.

2639. *The varieties of grapes are extremely numerous:* vine-growers enumerate in their catalogues nearly three hundred, of which between fifty and sixty are cultivated in Britain. These are classed according to the form and colour of the fruit, and are thus stated by Professor Burnett, in his "Outlines of Botany:" 1, the round black, or purple grapes; the grapes from which port wine is made belong to these; 2, the long black ones, to which belong the Hamburgh grapes; 3, the round white, or green grapes; 4, the long white and green ones; to the last two belong those brought from Portugal and Spain, packed in earthern jars; 5, the grapes of any other colours, such as red, roseate, blue, grayish, or variegated in stripes.

2640. *Of the round black grapes*, the most esteemed are the Damascus, the black Lisbon, the Muscat or purple Constantia, and the black Morocco. The claret grape is remarkable for its juicy pulp, being of a deep purple or blood colour, while in the others the dark tint is confined to the skin. The Ascalon, or black Corinth, when dried, constitutes the *currants* of commerce.

2641. *Of the long black grapes*, the best are Muscadel, the Burgundy, the purple Hamburgh, the black raisin, and the black Palestine.

2642. *Of the round white grapes*, the amber Muscadine, the malmsey Muscadine, the white Muscadine, the Pearl-drop, and the white Constantia are all excellent. The white Corinth or Ascalon is often without pips, and, when dried, is known as *Sultana* raisins.

2643. *Of the long white grapes*, the white Sokars, the white Muscat, the Morillon, or genuine Tokay, the white raisin, and others might be mentioned. The Verdelho, from which Madeira is made, is an excellent grape, but the stones should be rejected, as they are said to be deleterious when eaten.

2644. *Of the fancy grapes*, the red Muscat, the blue Tokay, the striped Aleppo, and the variegated Chasselas, are all worthy of cultivation.

2645. *Switzer informs us* that it is to Lord Capel and Sir William Temple we owe that collection of good grapes now so plentiful in England. The latter brought over the Chasselas and Frontignan, Amboyna, Burgundy, black Muscat, and grizzly Frontignan, and distributed them among the nurserymen, nobility, and gentry.

2646. *Grapes for the dessert* should be of a fine flavour, thin-skinned, sweet, and juicy. There is a superior richness in the black, blue, and red Frontignans, and there is a peculiar delicacy in the flesh of the white sweet water, which is also remarkably thin-skinned, with large berries. Grapes of the green and black sorts are imported from Portugal, and likewise from Malaga, and other parts of Spain, packed in large earthen jars having the interstices filled up with chaff, and the lids cemented down. They arrive here in little less than a week by the steam-packets. This method of preserving grapes was known to the Romans, and is described by Columella. Grapes are also brought from Hamburgh and Frankenthal, and sold at one shilling, and even eight pence per pound: arriving in less than twenty-four hours from Holland, they have all the plumpness and bloom of fresh-gathered fruit.

2647. *Used as food*, grapes are extremely nutritive in general, and very wholesome if quite ripe. They are better eaten with bread, as is the case in France, where they form a frequent breakfast for the working classes. Of the juice of unripe grapes, a pleasant cooling summer beverage is made; but the fruit should not be eaten in that state. The chemical composition of grape juice will be stated when treating of the mode of making grape wine.

2648. *Raisins* are grapes that have been allowed to shrivel and dry partly on the tree; they are then cut off and dried in the sun; hence they are sometimes called *sun raisins*, to distinguish them from others dried in ovens. They are also called *jar raisins*, because they come to us in jars. By drying they lose about two thirds of their weight, and become covered with a saccharine exudation. Some raisins come from Spain, Calabria, Smyrna, &c.. The Malaga are the largest and most highly prized for the table, known here generally as *Muscatel*, and sell for double the price of any other. They are the produce of the provinces of Valentia and Grenada. On the hills round Malaga there are upward of 7000 vineyards. The first gathering of grapes for some raisins commences in June; from those gathered in September, *Xeres Secco*, or *sherry*, is made, the sack of Shakspeare; and a third, in October and November, produces the wine known on the Continent as *Malaga*, and in England as *mountain*. *Common raisins* are made from various kinds of grapes, better or worse; they have a slight degree of acidity, which renders them less agreeable than the best.

2649. *Dried currants*, so much used in Christmas pies and puddings, are a kind of little raisins, or dried grapes, that grow in, and are brought from, the Ionian Islands. The chief place from which they were formerly imported was the Morea, or the Isthmus of Corinth, whence the name, *corinths*, converted into *currants*.

2650. The island of Zante is the chief place from which currants are now brought; some are from Cephalonia and Ithaca. When they are collected in August from the vines, which grow quite low, they are spread out and dried in the sun, and then packed in casks quite close till they are wanted. They get thus so fixed together that they require to be dug out with an iron instrument. See, farther, on the subject of grapes, in Book VIII., Chap. IV., "On Wines."

SUBSECT. 3.—*Melon* (*Cucumis Melo*, Linn.).

2651. The flesh of this fruit is very delicious, being succulent, cool, and high-flavoured. With us it is used only at the dessert, and is generally eaten with sugar, ginger, or pepper; but in France it is likewise served up at dinner as a sauce for boiled meats. It grows wild in Tartary, and has been lately found in abundance on the sandy plains of Icypoor. It was brought originally from Asia by the Romans, and is said to have been common in England in the time of Edward III., though it is supposed that it was lost again, as well as the cucumber, during the wars of York and Lancaster.

The best kind, called the *Cantaloupe*, from the name of a place near Rome where it was first cultivated in Europe, is a native of Armenia, where it grows so plentifully that a horse load may be bought for a crown.

Melons require a high temperature to raise them in perfection; and though no country has a greater variety of them than England, yet they have a high price in our markets. In France they are grown in such abundance that whole villages are occupied exclusively with their cultivation; and, in consequence of the practice which the people have, their culture is well understood. While in France and England melons are grown as articles of luxury, in some parts of the East they are used as necessaries of life. Niebuhr informs us that in Africa melons are planted in the fields, and that they are used by all ranks of Arabians as common food.

2652. *But although the melon is a very delicious fruit, it is not one of the most wholesome*; and the coldness of its nature demands that it should be accompanied by warm and stimulating condiments. Large melons are too often preferred on account of their showy appearance; but the small ones, when ripe, are often the most highly flavoured. There are many varieties of this fruit of several degrees of excellence. When a melon is perfectly fine, it is full without any vacuity; this is known by knocking upon it; and when cut, the flesh should be dry, no water running out, only a little dew, which should be of a fine reddish colour.

2653. *The watermelon* requires a warm climate to bring it to perfection in the open air. Its sweet and succulent flesh, and gratefully cool juice, render it particularly agreeable in those countries where it grows abundantly. The juice is sucked out by a hole made in the rind. In Upper Egypt, whole districts on the banks of rivers are planted with watermelons; they grow in sand. The Egyptians eat them in such abundance that they would seem to be almost their only meat and drink, and they form their most common medicine in cases of ardent fever; but Hasselquist recommends caution in their use, "as they chilled his stomach like ice." The fruit often grows to a large size in this country; but in Senegal one has been known to weigh sixty pounds. In some parts of India, where rain does not fall for fifteen months, watermelons sometimes weigh from fifteen to seventy pounds. They were introduced into England with the common melon, but are seldom cultivated, as the juice, though useful in a warm climate, is insipid. One kind of watermelon is pickled like gherkins, and is much used by the French cooks in their fricassees; it is also sometimes baked in sweet wine.

Subsect. 4.—*Cucumber* (*Cucumis Sativus*, Linn.).

2654. *This fruit is allied to the melon*, though far inferior in point of flavour. It appears to have been cultivated at a very early period, for it is mentioned in the Mosaic history as one of the fruits which the Israelites enjoyed in Egypt, and of which they regretted the loss. We are informed by travellers that it, together with other fruits of this class, still forms a great part of the food of the people in Egypt. Bishop Heber saw them raised in India beyond the Ganges, and Burckhardt observed them in Palestine. Pliny mentions them as growing in great quantities in Africa. It was a very great favourite among the Romans, who raised them by artificial heat, and they were introduced into England together with the melon.

2655. *Cucumbers are chiefly used as salad with meat or fish*, and young ones are pickled under the name of *gherkins*. They are cold, and more difficult of digestion than most vegetables when eaten raw; and they are generally dressed with pepper, vinegar, and oil, chiefly with a view to correct their cold qualities. Cucumbers are now much less used in their natural state than formerly among wealthy families; but they are in request for stews and made dishes, and when preserved they are esteemed one of the most agreeable sweetmeats. They are excellent, and more wholesome when stewed with gravy. The expressed juice of the cucumber is employed as a cosmetic, giving a pleasant suppleness to the skin, and it enters into the composition of several French pomades.

Subsect. 5.—*Fig* (*Ficus Carica*).

2656. *The fig-tree is a native of Asia*, and was known to the Israelites, as we learn from the Scriptures. The fruit appears to have formed a principal article of food among the inhabitants of ancient Syria and Greece, and was so much esteemed for its nutritive qualities, that it was considered as an emblem of fruitfulness. Like the cerealia, it enjoys a considerable range of latitude.

Dried figs and barley-bread are a general food among the lower classes of Greece in the present day. In the northern parts of France there are many fig gardens; but it is not generally cultivated in England, except on walls, or in the hot-house, the climate being scarcely warm enough to admit of its flourishing as a standard in the open air; nevertheless, it will ripen its fruit in some open situations in the south part of England. There is an orchard of fig-trees at Tarring, near Worthing, where the fruit ripens nearly as well as in Spain, and the trees are exceedingly productive. There are also some fig-trees above thirty feet high in the gardens at Arundel Castle. Figs grow, likewise, in some other places, and there is no doubt that they could be easily raised for fruit on the coast of Sussex, if sufficient attention were paid to that object. It is generally supposed that the fig was not planted in England before the reign of Henry VIII., when the arts began to be encouraged, and noblemen's houses first put on the air of Italian magnificence. There are at present some fig-trees in the Episcopal Gardens at Lambeth, said to have been planted by Cardinal Pole; and at Oxford, in the Botanic Garden of the Regius Professor of Hebrew, there is a fig-tree which was brought from the East, and planted by Dr. Pococke in 1648.

2657. *The fig contains* a large portion of sugar, without acidity or oiliness, and is of easier digestion than any other of the sweet fruits. They are considered to be laxative.

2658. *The best dried kinds* come from Turkey, Italy, Provence, and Spain. Smyrna is a great mart; but the figs of the Grecian Archipelago are inferior to those of Europe. Figs are prepared by dipping the ripe fruit in a scalding hot lye made of the ashes of the fig-tree, and then dried in the sun, or in ovens, and packed very close in chests. In the Canaries, Portugal, and the Grecian islands they make a kind of brandy from them.

In medicine, figs are employed as emollient cataplasms and pectoral decoctions

Subsect. 6.—*Tamarind* (*Tamarindus Indica*).

2659. The tamarind is the fruit, or, rather, pod of a tree which is a native of the East and West Indies, and thrives also in Egypt, Palestine, and Arabia. In the countries where it is produced it forms occasionally an article of food, in the form of confectionery, and is esteemed on account of its pleasant acid and cooling qualities, so useful in a warm climate. The pod consists of two parts; the outer is fleshy, and the inner thin as the finest parchment: between these two there is a space of about a quarter of an inch, which is filled up with a soft, pulpy substance of a tart but agreeable taste; this, and

the seeds which are enclosed in the inner pod, are fastened together by many slender fibres from the woody stalk which runs through the pod. The tree is common in Jamaica, is extremely beautiful, and grows to a great size, with large, spreading branches, and a thick and luxuriant foliage. The pods are gathered when ripe, freed from the shelly fragments, and placed in layers in a cask; boiling sirup is then poured over them till the cask is filled; the sirup pervades every part quite to the bottom, and when cool the heads of the casks are fixed down for sale. The more elegant method, however, is to clarify the juice of the fruit with the white of eggs, and form it with sugar into a clear, transparent sirup; this or the fruit supplies an agreeable and cooling beverage. The East India tamarinds are generally preserved by putting alternate layers of tamarinds and powdered sugar into a stone jar, by which means the fruit retains more of its natural taste and appearance. They are also sent from the East Indies in their natural state without sugar; but except these are kept in very close jars, they are apt to get musty.

2660. *According to Vauquelin, tamarinds contain* in the pulp, independent of the sugar used to preserve it, super-tartrate of potassa, gum, jelly, citric acid, tartaric acid, malic acid, and a feculent matter. The acid taste depends chiefly upon the citric acid, the quantity of that being the greatest.

Sect. VI.—Nuts.

2661. *These are seeds or fruits rather dry*, and not fleshy or pulpy, enclosed in a hard woody shell or husk. Nuts of various kinds are spoken of as much employed for food in ancient times, and they still furnish in some countries a considerable source of aliment.

2662. *The edible part, or kernel, usually contains a good deal of oil*, and although they are nutritive, they are less digestible than most other vegetable substances. The principal fruits of this class used as food in England are the walnut, chestnut, and filbert, grown in England, to which we may add the acorn, the exotics, cocoanut, cashew nut, and pistachio nut.

Subsect. 1.—*Walnut* (*Juglans Regia*, Linn.).

2663. The walnut is a native of Persia, the Caucasus, and China, but was introduced to this kingdom from France.

2664. *The ripe kernel is brought to the dessert* on account of its agreeable flavour, and the fruit is also much used in the green state, before the stone hardens, as a pickle. In Spain grated walnuts are employed in tarts and other dishes. The walnut abounds in oil, which is expressed, and which, being of a highly drying nature, and very limpid, is much employed for delicate painting. This, on the Continent, is sometimes used as a substitute for olive oil in cooking, but is very apt to turn rancid. It is also manufactured into a kind of soap. The marc, or refuse matter after the oil is extracted, proves very nutritious for poultry or other domestic animals; in Switzerland this is eaten by poor people, under the name of *pain amer*.

2665. The sap of the walnut-tree is very saccharine, and sugar may be made from it by evaporation; it may also be fermented into a kind of wine. The leaves and green husks afford an extract, by maceration in warm water, that acts as a very permanent brown dye for staining hair, wool, and wood, and is said to be employed by the gipsies to give a dark colour to children whom they have stolen.

Subsect. 2.—*Chestnut* (*Fagus Castanea*, Linn.).

2666. The chestnut was known to the Romans, who called it Castanea, from a city of that name in Thessaly, whence they first procured it; and it was grown abundantly by the ancients, and much used as food. It is so common in Italy and France that it is often considered to be a native of these countries. The chestnut lives to a very great age, and forms some of the oldest trees in the world; as the celebrated one mentioned by Brydone on Mount Ætna, under which a hundred horsemen are said once to have taken shelter; that at Fortworth in Gloucestershire, and one at Marsham, calculated to be 1100 years old. This tree was probably introduced into England by the Romans. It grows commonly in the warmer parts of Britain; but the fruit seldom comes to maturity in Scotland.

2667. In the southern parts of the Continent, chestnuts form a very large portion of the food of the labouring classes, who, besides eating them both raw and roasted, make puddings of them, and polenta for pastry. Boiled chestnuts and milk form a common breakfast among the peasantry in the south of France; and in Corsica, as well as several districts of Spain, they are cooked in various ways. Mr. Phillips says (*Pomarium Brit.*, p. 95), "Chestnuts stewed with cream make a much admired dish, and many families prefer them to all other stuffings for turkeys: they make an excellent soup, and I have no doubt but that chestnuts might be advantageously used in cooking, so as to make many agreeable and wholesome dishes. I have had them stewed and brought to table with salt fish, when they have been much admired; but it is exceedingly difficult to introduce any article as food that has not been established by long custom; and it is not more strange than true that the difficulty increases if the object be economy."

2668. The chestnuts that grow commonly in this country are inferior in size and perfection to those which are imported from Spain, Portugal, and Italy: these are frequently kiln-dried to prevent germination in the passage. In Britain, little use is made of the chestnut except at the dessert, for which it is roasted, when it becomes farinaceous or mealy, like a sweet potato.

2669. It is, indeed, the most farinaceous and the least oily of all the nuts, and therefore it is the most easy of digestion; but raw chestnuts are not digestible by every one.

2670. *The tree called the horse-chestnut, from the resemblance of its fruit to that of the chestnut, is very different.* Its fruits are astringent and bitter, and unfit for human food; nevertheless, they contain so much farinaceous matter, that they are very nutritious to some animals, and horses and deer devour them greedily. They are likewise detergent, and have been used as a substitute for soap. A patent was taken out some years ago for preparing starch from them, by which much corn might be saved.

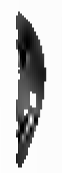
SUBSECT. 3.—*Hazelnuts and Filberts* (*Corylus Avellana*, Linn.).

2671. *The common hazel is the wild, and the filbert the cultivated state of the same tree.* The hazel is found wild, not only in forests and hedges, in dingles and ravines, but occurs in extensive tracts in the more northern and mountainous parts of the country. It was formerly one of the most abundant of those trees which are indigenous in this island. It is seldom cultivated as a fruit tree, though, perhaps, its nuts are superior in flavour to the others. The *Spanish nuts* imported are a superior kind, but they are somewhat oily, and rather indigestible. *Filberts*, both the red and the white, and the cob-nut are supposed to be merely varieties of the common hazel, which have been produced, partly by the superiority of soil and climate, and partly by culture. They were originally brought out of Greece to Italy, from whence they have found their way to Holland, and from that to England. It is supposed that, within a few miles of Maidstone, in Kent, there are more filberts growing than in all England besides; and it is from that place that the London market is supplied. The filbert is longer than the common nut, though of the same thickness, and has a larger kernel. The cob-nut is a still larger variety, and is roundish. Filberts are more esteemed at the dessert than common nuts, and are generally eaten with salt. They are very free from oil, and disagree with few persons.

SUBSECT. 4.—*Cocoanut.*

2672. *This magnificent nut* is the produce of one of the palms (*Cocos nucifera*) which grows wild abundantly in the eastern parts of Asia and the islands of the Indian seas, from which it has been introduced into every part of the tropical regions, the property which the fruit has of not being destroyed by sea-water, favouring its transportation. The tree, like the rest of the palms, is tall and straight, being from thirty to sixty feet in height, and sometimes more, having the leaves only at the top, and the nuts hanging in bunches of about a dozen each, under the leaves: one tree, in a good soil, has sometimes a hundred cocoanuts annually. Some trees will bear blossoms every four or five weeks; hence there are generally fresh flowers and ripe nuts on the tree at the same time. The tree will continue to flourish for a century.

2673. The fruit is covered externally by a thin, tough rind, of a brownish-red colour.



Immediately within this is a quantity of tough fibres (*fig.* 518), and in the midst is enclosed the nut itself, which consists of a very hard shell, containing a kernel of a white substance, being itself hollow. The kernel, in its fresh state, is very nutritive, containing a good deal of fixed oil. It is eaten raw, or made into cakes or fritters when rasped; but, when it arrives in England, it is generally dry and indigestible. While the nut is green, the whole of the shell is filled with a juice called the milk, which is agreeably sweet and refreshing. When this can be procured, in its native country, it forms a delicious beverage; it is used as milk with coffee, and is employed for custards, blancmange, &c., but it is seldom found in any quantity in the cocoanuts brought to England: a large nut, when fresh, will give half a pint of milk. When it is very young, the pulp is so soft that it may be eaten with a spoon, and, with a little Madeira wine and lime juice, is excellent. When about a quarter ripe, the shell is thin, and so transparent that it is used to hold a light by way of a lantern: there are three holes in it, which give it somewhat the appearance of a monkey's head; from one of these the germe, or young plant, rises when the nut is planted in the ground. The oil obtained by pressure from the kernel is used for burning in lamps.

2674. *Perhaps no tree furnishes so many useful products as the cocoa, and, where it exists in abundance, it seems to supply almost all the necessaries of life.* The woody shell of the trunk, when of considerable age, is tough and durable, and is employed in building huts; it is sometimes so hard as even to be capable of receiving a very fine polish. The terminal leaf buds at the top of the tree are very tender and delicate, and, when boiled, resemble cabbage: they are pickled with vinegar; but they can be had only at the expense of the tree, which dies if they are cut off. The bases of the leaf-stalks afford a reticulated substance, like gauze, that is used by the Indians for coverings for cradles and for strainers. The leaves themselves are used for thatching houses, and cottages are formed of them. Various articles are also manufactured from them, as baskets and wicker-work; also masks to protect the face from the sun: when young they are transparent, have a fine texture like satin, and are used for making lanterns; they are also employed for writing upon by scratching with a pointed iron instrument. Of the small leaves baskets for catching fish are made; also combs

and brooms. They serve also for fuel, and for torches in travelling, and to keep off wild beasts; their ashes, which contain much alkali, are used for washing or making soap. The central rib of the leaf is employed for oars, and the end of it, well bruised, answers as a broom or a brush for whitewashing. The fibrous coverings of the blossoms are made into aprons or petticoats for women. The fibres in the nut afford a material of which ropes and strong cables are twisted, which endure in salt water much better than those of hemp, and are even employed in manufacturing coarse sail-cloth: they are likewise used for stuffing mattresses, cushions, &c. The marc, or refuse of the nut after the oil is expressed, serves as food for cattle; and the roots of the tree are sometimes chewed by the Indians instead of areca or betel nut. Of the shell of the nut a great variety of drinking-cups, ladles, spoons, and vessels of various kinds are made. From the sap of the tree, called toddy, arrack, a fermented liquor, is produced, superior to that from rice. When fresh toddy is boiled over a slow fire, it thickens into a sweet luscious substance, named *honey*, and, if this is farther boiled, it forms a coarse brown sugar, called *jaggery*, which is often dried into round cakes for keeping. In short, there is no part of the tree but is employed for some useful purpose, and it is certainly one of the most valuable gifts bestowed by Providence upon the inhabitants of tropical climates; and yet, with respect to fruit, the cocoanut tree is one of the least productive of the palm tribe. Another species of this class, the *Seje* palm, bears 8000 fruits at once; a single spathe of the date palm contains 12,000 flowers, each of which should afford one fruit; and in a third species, the *Alfonsia Amygdalina*, there is the enormous number of 207,000 flowers on each spathe.

2675. *The cacaonut*, pronounced, improperly, *cocoa*, from which our chocolate is made, is a very different fruit from that just described; and as it is not eaten as a fruit, we shall reserve our account of it to the description of "Cocoa used as a Beverage," Book VIII., Chap. XII.

Subsect. 5.—*Date* (*Phœnix Dactilifera*, Linn.).

2676. *This is the fruit of one of the palm tribe*, and forms a principal part of the food among the Arabs and inhabitants on the margin of the great sandy deserts in the north of Africa, where there is scarcely any other esculent vegetable. There this majestic monarch of the thirsty land, affording the only shade and food to be met with, is hailed by the traveller with greater pleasure than, perhaps, any tree in another situation. It shoots up a single straight stem to the height of fifty or sixty feet, and then throws out a magnificent crown of leaves, graceful and pinnated.

2677. The fruit, before it is ripe, is somewhat astringent, but when thoroughly mature it is excellent, being rich in sugar, gum, and other vegetable matter, with little acid; it is extremely agreeable and sweet, and affords wholesome nutriment. If required to be kept or transported, it must be dried in the sun. The Arabs reduce dates, when dried, to a kind of meal, which they preserve for food when they undertake long journeys across the deserts, and they will subsist for a considerable time upon date-bread.

2678. In Egypt an agreeable conserve is made of fresh ripe dates. They form a kind of solid paste or cake of them, by pressing them into baskets while soft, and in this state they are brought to market, and cut out in lumps, which are sold by weight for the daily food of the inhabitants. Mixed with water, they also compose a refreshing drink. The wood and leaves of the date-tree serve for many of the same uses to which the cocoanut palm is applied, above mentioned.

2679. *Dr Clarke observes that a single date palm* will bear upward of a hundred weight, and sometimes between two and three hundred weight of dates in a season: they come into bearing at about six to ten years of age, and are fruitful for upward of two hundred years. The young shoots are good to eat, and resemble asparagus. The stem of the date-tree likewise affords an inferior kind of sago, and from its juice a fermented liquor is made.

2680. *Dates are imported into Britain in a dried state* from Barbary and Egypt, and, when in good condition, they are much esteemed. An inferior kind has lately become common, which are dried hard, and have little or no flavour. They should be chosen large, softish, not much wrinkled, of a reddish yellow colour on the outside, with a whitish membrane between the flesh and the stone.

Subsect. 6.—*Cashew Nut* (*Anacardium Occidentale*, Linn.).

2681. This is a tropical production. The nut (*fig.* 516), which a good deal resembles the walnut, grows at the end of the fleshy, pea-shaped receptacle called the apple. It has an agreeable sub-acid taste, and may be fermented into a kind of wine. The juice is also much used in the West Indies for making punch and other beverages.

2682. The eatable kernel is contained within two shells, and between these shells there is a thick rust-coloured liquor, extremely inflammable, and so caustic that it will blister the skin: this is used as an indelible marking ink for linen. The kernel is of a very fine flavour, preferable to the walnut, and employed in puddings and many other compositions of the cook, abounding in a delicious milky juice when fresh, and may be eaten raw, roasted, or pickled. Some also grind it with cacao in making chocolate, the flavour of which it is said to improve.

2683. The broken nuts are used for steeping in old Madeira wines to improve their flavour. The acrid inflammable oil of the shell should be burned out before the nut is eaten; for, if incautiously cracked by the hands or teeth, the caustic oil will blister the

lips and excoriate the skin where it touches. It is said that the milky juice of the tree itself, obtained by tapping or incision, forms a black marking ink for linen that cannot be washed out. The nuts are eaten abundantly by the negroes in Brazil.

SUBSECT. 7.—*Pistachio Nuts* (*Pistachia Vera*).

2684. These nuts are brought to us from Sicily and Syria, where they grow upon a kind of turpentine-tree. They are oblong and pointed, about the size and shape of a filbert, including a kernel of a pale greenish-colour. Their taste is very agreeable, much resembling that of sweet almonds; but they are sweeter, have more flavour, and are more oily; hence they are liable to become rancid. On the Continent, in places where they are plentiful, they enter into the composition of ragouts and various dishes. A variety (*P. Atlantica*) is slightly acid, and is made, with dates, into cakes by the Arabs.

SUBSECT. 8.—*Brazil Nut.*

2685. These are also called *chestnuts of Brazil*, and are brought to us from Para. They are much esteemed, having a kernel resembling that of the almond, but larger, containing a great deal of oil, and tasting more like the hazelnut. The kernel, of a wedge-like form, is found within a very hard shell, as large as a child's head, which grows in clusters of fifteen or twenty. The tree which produces them is a Juvia, rising to the height of 100 or 120 feet, and abounding on the banks of the Oronoco.

SUBSECT. 9.—*Acorn.*

2686. The acorn, which is the well-known fruit or nut of the *oak-tree* (*Quercus*, Linn.), formed part of the food of man in the early ages, before the use of corn was known, and frequent allusion is made to this circumstance by the classic writers. They are seldom used at present, except for the fattening of hogs, deer, and poultry.

It is not certain that the acorn was ever employed as the common food of the inhabitants of this island, although they might have been among the ancient Britons. Oak forests in the time of the Saxons were much prized, chiefly for the fruit, which was useful for fattening hogs, the flesh of which was the principal food of the people at that time, a circumstance attributable to the great rapidity with which the hog multiplies his species, and the little preparation required for its maintenance.

2687. The fattening of hogs upon acorns was, among the Saxons, considered as an important part of domestic economy. Droves of swine were fed in the woods, particularly in the New Forest of Hampshire and the Wealds of Sussex. This right which the people enjoyed was called *pannage;* and the being deprived of it by William the Norman, who had a passion for converting all the forests into hunting-grounds, was one of the public grievances which was redressed by Magna Charta. The name is Saxon, *acern* signifying corn of the oak.

2688. *The taste of common acorns is rough and disagreeable*, and they are astringent and difficult of digestion; even the hogs who feed upon them should go at large, and not be confined to the stye. Notwithstanding this objectionable quality, they have, in times of famine or great scarcity, been dried, ground into meal, and baked as bread in this country as well as in France, and it is said that they are still used in Norway and Sweden; but they are there first boiled in water, and mixed with one half or one third of corn flour, in which case they supply a nutritious food. Acorns are eaten at present in Spain, where they were long considered as a great delicacy, and even brought to the dessert. Cervantes often mentions them in his Don Quixote; but the Spanish acorns are sweeter than those of England. Some of the South American oaks produce acorns which are mild and nutritive. Acorns have been tried as a substitute for coffee, roasted, and having a little butter added to represent the oil in coffee; but they are not recommendable.

SECT. VII.—BERRIES.

2689. The name of berry (*Bacca*) is given to certain small fruits which consist of a pericarpium or skin full of juice or pulp, and seeds disposed throughout the pulp without any membranous capsule or covering. Almost all of those which we use as food grow upon shrubs cultivated in gardens, or are found wild on mountains or heaths. The most useful among them are the gooseberry, the currant, the raspberry, cranberry, and barberry, to which may be added the strawberry.

SUBSECT. 1.—*Gooseberry* (*Ribes Grossularia*, Linn.).

2690. This is perhaps the most useful of our fruits known by the name of berries. The best sorts form an excellent dessert fruit when ripe, and in their green or immature state they are employed in tarts, sauces, and creams. They are extremely useful when preserved, as they easily may be, throughout the winter. See Book X., Chap. IV., "Preservation of Food."

2691. The gooseberry is a native of cold climates, and is probably indigenous to these islands, or it has been long naturalized here, being found occasionally growing wild upon old walls, and in the woods and hedges in Cambridgeshire and Norfolk. It may be considered as peculiarly an English fruit, being produced in greater perfection here than in any part of the world. Foreigners are astonished at the size and flavour of this fruit among us. In Norway and Sweden the seasons are too rapid for its full development. The climate of Holland and some parts of Germany appear to suit it, and the pale kinds were first brought from Flanders in the time of Henry VIII. It grows wild in many parts of Europe, but the southern parts are too warm for it. Although it is found in Piedmont, the fruit is astringent and neglected. It is scarcely known in Italy and Spain, and in France it is little esteemed.

2692. *In its uncultivated state* it is a small berry, and it has been brought to its present state of perfection by the skill of English and Dutch gardeners; it may be easily raised in every cottage garden. The largest and finest in appearance are grown in Lancashire,

where prizes are given for producing the largest; and the size of some shown upon these occasions is extraordinary, weighing an ounce or an ounce and a half. One gooseberry, exhibited in 1825, weighed 31 dwt. 16 grains; but the flavour of the very large sorts is inferior to that of the smaller kinds.

2693. *It would appear that the flavour improves with the coldness of the climate*, provided there be sufficient warmth to ripen them; for those grown in Scotland as far north as Aberdeen, and even Inverness, are of superior flavour.

2694. *There are numerous varieties of this fruit.* In vol. i., Series II., of the Transactions of the Horticultural Society, there is an account of seventy sorts, selected from those fruited in the Society's garden, and which were reckoned to have a good flavour, many of the large kinds having been rejected, their size not compensating for their coarseness. Some of the Lancashire growers enumerate above 300 sorts. The varieties are formed into four divisions, according to their colour when ripe, red, yellow, green, and white; and each of these again into hispid, downy, or smooth. The yellow gooseberries, in general, are sweeter, and have a more rich and vinous flavour than the white, which are often insipid. The green are sometimes extremely sweet, but generally inferior to the yellow, though sometimes very large. Of the red varieties, some are excellent, others rather acid; in short, every year produces new varieties, so that it is difficult to speak definitely of their characters. Some of them are early, and others late; of the latter, the variety called the *Pitmanston green-gage* is particularly deserving of notice, and in some seasons will hang till it shrivels, and almost candies on the tree. Gooseberries are not only very easily cultivated, but are, perhaps, the most wholesome of our fruits; and besides their use in the ordinary way, they are employed successfully for making excellent wine, which sparkles when the cork is drawn, and, when well made, is nearly equal to Champagne, and often passes for it. They are the earliest, as well as one of the best fruits for spring tarts, and are very easily preserved in the green state through the winter, so as to retain their natural flavour for tarts, cream, &c.; and when ripe, and preserved with sugar, they make excellent jams and jellies. From gooseberries being so useful for many purposes, both in a green and mature state, care is taken by the gardeners to have a succession of them through the summer months. The early sorts gathered green for tarts are to be had in April, or early in May, and until August. Some are ripe in June, and ripe gooseberries of a late sort are kept on the trees till September.

2695. *The pleasant acidulous flavour of the gooseberry is owing to the presence of malic and citric acid blended with sugar*; and upon the varied proportions in which these two principles are developed depends the fitness of the several varieties for dessert or kitchen use, for preserving, or for making wine.

Gooseberries and currants contain a large proportion of what has been named by chemists *pectic acid*, remarkable for forming the gelatinous coagulum when mixed with water, well known by the name of *jelly*.

2696. *The term gooseberry is supposed* to be a corruption of *grossberry*, the name among the ancient Latins being *grossularia*, from their resemblance to small unripe figs, or *grossi*; whence, also, the French *groseilles*.

2697. *The acid of gooseberries* may be procured in a separate form, the method of which is a late discovery by a French chemist. He ferments the gooseberry juice, distils off ardent spirit from it, which he reserves; the residual liquor he saturates with chalk, washes the insoluble powder thus produced, treats it with sulphuric acid, as in the process for extracting the crystallized lemons, filters off the liquor, and evaporates it, so that the crystals will form on cooling. By this mode 100 parts of gooseberries afford 10 of spirit, and 1 of crystallized acid, which is said to resemble citric acid.

Subsect. 2.—*Red and White Currants* (*Ribes Rubrum*, Linn.).

2698. Both these are considered to be varieties of the same species, since the berries in their wild state are all red, and it is cultivation that has produced the white and pale red varieties. There is little doubt that this elegant fruit is an improved native of Britain, being found wild (*Ribes sylvestre*) in many places. It has been supposed, however, that it has degenerated from the seedless grape of the Levant, still imported under the same name, currants. It is scarcely known in France, where it is distinguished from the gooseberry only by the name *groseilles en grappes*.

2699. *The white is preferred for the dessert*, being peculiarly juicy and cooling: they are best also for making wine. It is observed that all the white fruits of the berry kind are sweeter than the coloured, but other fruits that are coloured are generally sweeter than the white. Red currants are imported from Holland, and sold in Covent Garden market, after ours are out of season, at as low prices as our own. They are carefully packed in baskets of 15 or 20 lbs., and they consist only of large dry bunches, which keep better than ours. The red is used for tarts and in the preparation of jellies, and they are particularly useful, being easily preserved during the winter in bottles. Currants are not difficult to cultivate, and, being very hardy, they come within the attainment of every cottager who has a garden; when they are trained against the walls of

the cottage they have an elegant appearance, not unlike that of the vine. Like gooseberries, they owe their pleasant flavour to the sugar and malic and pectic acids which they contain.

Subsect. 3.—*Black Currant* (*Ribes Nigrum*, Linn.).

2700. *The black currant is a distinct species*, is a native of most parts of Northern Europe, and is certainly indigenous in Britain, being found growing wild in woods, wet hedges, and other moist situations. The fruit, which has a peculiar flavour disliked by some, is occasionally, though seldom, brought to the dessert, but is eaten in puddings and tarts, and made into jelly, which is supposed to have a medicinal quality, and is used for hoarseness and sore throats. In Russia, where it grows in great abundance, and of a large size, they make a wine from it, and it is put into brandy, as cherries are in England: in Ireland it is put into whiskey. Cottagers in England, as in Siberia, sometimes mix the dried leaves of the tree with black tea, which gives nearly the flavour of a mixture with green tea; and it is suspected that tea is sometimes adulterated in this manner. When trained against a wall the berries grow to an extraordinary size. The varieties called the *black Naples* and the *black grape* are excellent for the dessert.

Subsect. 4.—*Raspberry* (*Rubus Idæus*, Linn.).

2701. This fruit derives its Linnæan appellation, "Idæus," from Mount Ida, where Pliny describes it to have grown. It was considered as a sort of bramble, though much improved by cultivation, and our name of raspberry is given to it from the rough spines with which the bush is covered.

2702. *There are two varieties*, the red and the white, both natives of Britain, and excellent for the dessert: the white is the sweetest. The flavour of the fruit is peculiar, but is very generally liked; it is, however, extremely volatile; even a few hours will diminish it, and, to be enjoyed in perfection, the fruit should be eaten off the bush. If kept for two or three days, the flavour will be almost entirely gone. The fruit is subacid and cooling, and the red is much used in tarts, and for jams, ices, &c. It also makes a delicious wine, and is employed for raspberry brandy and raspberry vinegar, a table spoonful of which in spring water makes a most refreshing beverage.

2703. Vast quantities are cultivated in the neighbourhood of Isleworth and Brentford, whence they are brought to Covent Garden market.

Subsect. 5.—*Strawberry* (*Fragaria Vesca*, Linn.).

2704. *The name of this favourite fruit* is said to be derived from an ancient custom of putting straw beneath the fruit when it began to ripen, which is now little attended to, but which is very useful to keep it moist and clean. The strawberry belongs to temperate and rather cold climates, and no fruit of these latitudes that ripens without the aid of artificial heat is at all comparable with it in point of flavour. The strawberry is widely diffused, being found in most parts of the world, particularly in Europe and America.

2705. The fruit has a delicious fragrance, and is universally esteemed for its agreeable flavour. It possesses a peculiar advantage of not creating acidity when taken into the stomach. It is nutritious, and very wholesome, and may be safely eaten by gouty and rheumatic patients who have been forbidden the use of other fruit. In addition to its grateful flavour, it is sub-acid and cooling, which renders it particularly agreeable in summer. Strawberries may be eaten alone, or with sugar and cream, and physicians consider them not only as wholesome, but rank them among their pleasant remedies, particularly in feverish habits.

2706. *The varieties are extremely numerous, but the principal strawberries*, as the *scarlet* and *Chili*, have been brought from America two hundred years ago: of these the *pine* is most esteemed, and the *hautboy*, though generally excellent, is the most variable.

2707. *Strawberries ripen* from June to August and September; but the main crop is over in July. One variety, a small red strawberry, grows wild in our woods, and is mentioned as an article of ordinary consumption in the time of Henry VI. The fine aromatic flavour of this fruit is not very durable, and a slight shower will sometimes almost entirely destroy it; on this account it should be gathered in dry weather, and the same day when it is to be sent to table. The strawberry is a kind of rock plant, and grows best on artificial banks, composed partly of broken fragments of rock.

Subsect. 6.—*Mulberry* (*Morus*, Linn.).

2708. The mulberry-tree is a native of Asia, and has been always a most valuable tree to the Chinese and Persians for feeding their silk worms. There are several species.

2709. The *white mulberry* (*Morus alba*) is a delicate tree, though it grows well in Spain, Italy, and the south of France; the berries are light-coloured and insipid, but its leaves are the best for feeding the silk-worm. It is seldom cultivated in this country.

2710. The *black mulberry* (*Morus nigra*) is a larger and more hardy tree, and is very commonly grown in England: the fruit is a blackish-red, and its juice stains the hands a deep colour: it is excellent for making a peculiar wine.

2711. *Mulberries are brought to the dessert*, and are esteemed for their highly aromatic flavour, and their sub-acid nature. They are considered as cooling, laxative, and generally wholesome. This fruit was very highly esteemed by the Romans, who appear to have preferred it to every other. The mulberry-tree is stated to have been introduced into this country in 1548, being first planted at Sion House, where the original trees still thrive. The planting of them was much encouraged by King James I., about 1605; and considerable attempts were made at the time to rear silk-worms on a large scale, for the purpose of making silk; but these endeavours have always failed, the climate being scarcely warm enough.

Subsect. 7.—*Elderberry.*

2712. *The common elder-tree* (*Sambucus nigra*, Linn.) is a native of this country, and is found near wet ditches and old walls. The wine made from elderberries is too well known by families in the country to require any encomium; it is almost the only wine that the cottager can procure, and, when well made, is a most excellent and wholesome beverage. That made from the white elderberry resembles some rich grape wine. The young tender shoots are much relished as a pickle; and if a sirup be made from ripe elderberries, with a few bitter almonds, and added to brandy, it has all the flavour of the very best cherry brandy.

2713. Professor Martin observes that this tree contains a whole magazine of physic to rustic practitioners. An excellent healing ointment is made from the green inner bark, and also with the leaves and flowers. Infusions of the flowers promote cuticular secretion, and form a powerful sudorific. The juice of the inner bark is one of the best hydragogues. No quadruped will eat the leaves of this tree, which also drive away all insects, except the peculiar ones that feed upon them.

Subsect. 8.—*Barberry* (*Berberis Vulgaris*, Linn.).

2714. The barberry is found in woods, coppices, and hedges in England, and is a native. The flowers are small and beautiful, and, when they first appear, have a perfume like cowslips, but which change to a putrid and most disagreeable smell, particularly towards the commencement and at the decay of the flowers. The fruit is extremely acid and astringent, but is cooling, and is thought to create appetite, though seldom eaten. Conserves and jellies made of it are refreshing and strengthening to the stomach. Barberries are employed as pickles and for sirups, which are considered as medicinal. There are several kinds; the fruit of some have stones, and others are without.

Subsect. 9.—*Whortleberry* (*Vaccinium Myrtillus*, Linn.).

2715. This is called also the *hartleberry* and *bilberry*. It grows wild abundantly upon our heathy commons and uncultivated hills. It is plentiful in the north of Europe. It is found on Leith Hill in Surrey, also in Devon. The fruit is seldom brought to the London market, although much relished by some persons in tarts or cream, or made into jellies. There are several varieties: the purple are rather larger than juniper-berries, and are covered with a fine blue or purple powder, like the bloom of plums. They are seldom cultivated.

Subsect. 10.—*Cranberry* (*Vaccinium Uliginosum*, Linn.).

2716. This berry is a red variety of the whortle, and is much esteemed in tarts or with cream. It is scarcely cultivated in gardens, but grows wild plentifully in peaty bogs and marshes, particularly in Lincolnshire, Sussex, Cumberland, and other similar places in Britain; also in Scotland. Considerable quantities of fine fruit are also imported from Russia and Germany, packed in casks. A large sort is brought from North America, and is used by the London pastry-cooks for tarts; but this kind is inferior to the English cranberries, Some have been brought from New-Holland, of a superior flavour.

2717. Cranberries are considerably astringent, and are thought to restore the appetite; they have a peculiar grateful flavour, something like black currants. They are easily preserved by drying them a little in the sun, and stopping them close in dry bottles. They are so plentiful in Cumberland that they are sold by the cart-load. The fruit is sometimes fermented into an intoxicating liquor, and is put into whiskey to disguise its peculiar flavour. It is said to possess narcotic powers, and is therefore also used in beer. It makes an excellent jelly, preferable to that from currants, for venison.

2718. *In the Transactions of the Horticultural Society, Mr. Milne recommends the cultivation of this berry*, which is now only collected in its wild state. He observes that both the British and American species may be grown with much advantage in numberless situations in this island, with little trouble, and on soils where few other useful plants will grow to advantage. Cottagers and others living in the neighbourhood of moors and heaths covered with soil suitable to their growth, might cultivate them with considerable profit for the market; and if they could not be consumed or disposed of in the neighbourhood, they might be sent to a great distance without the hazard of being spoiled. The American would be the easiest managed, and most productive for general use; but, as many prefer the flavour of the English cranberry, there would be also a demand for it, though at a higher price.

Subsect. 11.—*Blackberry*, or *Brambleberry* (*Rubus Fruticosus*, Linn.)

2719. This is a species of raspberry; it is the most common of our native berries, and

it is found in almost every hedge, being rather annoying with its long training stems and sharp thorns. In Wales it grows to a large size, and, in a fine summer, is really an excellent fruit. The berries are slightly astringent, and are made into a jam useful in sore throats. They are occasionally used in tarts. The juice, mixed with raisin wine before it is fermented, will give it the colour, and much of the flavour of claret.

SUBSECT. 12.—*Dewberry* (*Rubus Cæsius*).

2720. Phillips, in his *Pomarium Britannica*, p. 71, says that this is a variety of the blackberry; the protuberances are larger and fewer in number than those of the common blackberry. It is generally found trailing on the banks of hedgerows or in hazel copses, seldom growing above a foot high. He observes, "that it is a berry of excellent flavour, and well deserving a place in cultivated grounds, as it must be equally beneficial to society that our native fruits should be improved, as well as that new varieties should be imported from climates that can give but little hope of their thriving without the aid of artificial heat."

SUBSECT. 13.—*Juniper-berry* (*Juniperus Communis*, Linn.).

2721. This is the fruit of the common juniper, which grows wild on our hills. They are round, of a blackish-purple colour: when chewed, they have, at first, a warm, sweetish, and afterward a bitter taste. In Sweden they are made into a conserve, and eaten at breakfast. In some places they are roasted, and used as a substitute for coffee. A volatile oil is contained in cells in the shell of the nut, and not in the fleshy part of the fruit, that has a close resemblance to oil of turpentine, and which is used to flavour gin; but the juniper-berries employed for this purpose are imported.

SUBSECT. 14.—*Service Berries*.

2722. These are the fruit of the *wild service-tree* (*Pyrus torminalis*), very common in the hedges and fields; but, though at present little known, they were more in use formerly. The country people in some places gather the bunches of berries, and hang them up in the air till they undergo an incipient putrefaction, in which state they possess a peculiar acid, astringent taste, and are considered as having cathartic properties. When mellowed by frost they have been used as food. The service-tree is a native of England, but is now seldom seen except planted as ornamental trees.

SECT. VIII.—EXOTIC FRUITS WHICH DO NOT RIPEN IN THE OPEN AIR IN ENGLAND, AND WHICH ARE ONLY CULTIVATED IN THE HOT-HOUSE.

2723. It does not enter into our plan to describe the vast number of fruits that are found in various parts of the world: the following are occasionally imported in a preserved state, or are sometimes cultivated in this country by the aid of artificial heat.

SUBSECT. 1.—*Pomegranate* (*Punica Granatum*, Linn.).

2724. The pomegranate, which derives its name from "*pomum granatum*," a kernelled apple, possesses, independently of its valuable qualities, great historical interest. We find it often mentioned in the Bible, where it is included in the fruits of Palestine, with the vine, the fig, the olive, and other "pleasant fruits." It likewise grows wild in Barbary. Pliny states that the Romans brought it from Carthage in the time of Sylla; hence its name, Punica. It was likewise well known to the ancient Greeks, and held in great esteem by them: the story of Proserpine is well known, who, having been carried off by Pluto, was prevented from returning to the earth in consequence of having tasted of this fruit in the Elysian Fields. They are frequently represented in ancient sculpture.

2725. *The fruit of the pomegranate-tree* is about the size and shape of an orange. The rind is coriaceous, of a reddish-yellow colour, having a very styptic taste; but the pulp is succulent, contained in cells divided by membranes, and crowded with seeds; the juice is of a pleasant acid taste, and particularly grateful and cooling in warm climates. It is said to assuage thirst in a degree quite peculiar to it, from its acid, which is full of "pleasant sweetness." All the rest of the plant is highly astringent. The bark has so much tannin that it is employed in Germany and other countries for making an imitation of Morocco leather, and the rind of the fruit will do instead of nut-galls for ink: it was also employed medicinally in ancient times, as it is still in some places at present.

2726. The pomegranate flourishes in the open air in the south of Europe; but in England, though it blossoms readily in the southern counties, the fruit requires a greenhouse to bring it to perfection. It was first brought to this country in 1548, during the reign of Henry VIII., and it was among the trees that fruited in the orange-house of Charles I. The tree sometimes attains the height of twenty feet, and is highly prized as an ornament on account of its beautiful scarlet blossoms, which are extremely fragrant. In the West Indies, where it has been planted, the fruit grows larger and finer-flavoured than in Europe. Its singular and beautiful appearance adds to the variety at the dessert.

SUBSECT. 2.—*Banana* (*Musa Sapientum*, Linn.).

2727. This fruit is very generally diffused over the torrid zone of the New World, and an immense portion of mankind subsist chiefly upon it, answering to them instead of the wheat, barley, and rye in Europe and Western Asia, and rice in India. The banana is not known in an uncultivated state: among the wildest tribes in South America, as well as in other places, it is propagated by suckers.

2728. *No individual plant in the vegetable kingdom produces so much nutriment in the same*

space of ground. The fruit is from five to seven or eight inches long, and sometimes a foot in circumference. Each plant will produce from 160 to 180 fruit, which grow in a bunch, and each bunch weighs from 60 to 80 pounds. Humboldt has observed that a European is surprised to see the smallness of the plantation of bananas round an Indian hut, which is found sufficient to maintain the family. A cultivated space of only 1000 square feet will admit of 30 to 40 bananas, which, together, will annually produce 4000 pounds weight of fruit: a produce 133 times greater than could be obtained from the same space if covered with wheat, and 44 times greater than if occupied by potatoes.

2729. *The form of the fruit* is somewhat like that of the cucumber, but of a highly grateful flavour, less luscious than the plantain, and composing an extremely nutritive and healthy aliment: the stalks are marked with purple spots, whereas that of the plantain is entirely green

The plantain is relished by all ranks of people in the West Indies, and is considered as preferable to bread in hot climates. Dr. Wright observes that no species of provision could supply its place; even wheaten bread would be less agreeable, and less capable of supporting the laborious negro, and enabling him to preserve his health. In America it is the custom to plant banana walks, which they extend as their family increases. Some or other of the plants are in bearing the whole year round. It is eaten raw, roasted, or boiled, and is made into fritters, preserves, and marmalades; and it is dried in the sun and preserved like figs. Meal is extracted from it by pounding Sometimes, after making it into a paste, they squeeze it through a sieve, form the mass into loaves, which are dried in the sun, or baked in hot ashes, after having been previously wrapped up in leaves. The fermented juice also affords an excellent wine.

2730. Bananas have been fruited in England in a hot-house. When the building is lofty enough they form a magnificent appearance, equal, if not superior, to what they present in their native climes.

Perfectly ripe bananas were produced in the hot-houses of the Royal Caledonian Horticultural Society, in Edinburgh, and were sent up to the Lord Mayor of London for the banquet given to the present queen at Guildhall, but, from some cause or other, were neglected to be mentioned in the published report, although certainly the rarest dish on that occasion.

2731. *Plantain* (*Musa Paradisiaca*, Linn.).—This fruit (*fig.* 517) is allied to the banana, but is a native of the Old World, growing in India and Africa, from whence it was carried to the West Indies.

2732. The fruit of the plantain is about the size of ordinary cucumbers. When ripe, it turns yellow, is sweet, of a mealy substance, tasting something like the melon, luscious, and dissolving in the mouth. It is brought to table as dessert, raw, fried, or roasted. It is used also in tarts, or dried, or preserved as a sweetmeat, and is considered as the most wholesome of all confectionery. The fruit grows in clusters on the tree, which is of the palm tribe, rising with a single stem to the height of fifteen or twenty feet, and having leaves only at top, each of which is about six feet long and two feet broad. The whole spike and fruit often weigh forty or fifty pounds.

SUBSECT. 3.—*Mango* (*Mangifera Indica*, Linn.).

2733. The mango (*fig* 518) is one of the most grateful to Europeans of all the tropical fruits. It resembles a short, thick cucumber in form, and grows upon trees forty or fifty feet high: it has a thin skin, and, on removing this, the interior consists of a pulp which melts in the mouth with a cooling sweetness, and a delicious, aromatic, and sub-acidulous taste. It is sometimes cut into slices and eaten with wine, or is candied to preserve it. In the heart is a small stone. The mangoes of Asia are said to excel those of America.

Fig. 518.

2734. In India they are constantly at the dessert in the hot months, and no fruit is held in such high estimation; it is extremely wholesome and nutritious. The green fruit is made into jellies, conserves, tarts, &c. The ripe is very perishable, and cannot be brought to this country except pickled, from which no idea can be formed of their exquisite flavour: altogether, they are considered as one of the chief dainties of the vegetable world, and are, consequently, cultivated wherever the climate admits of it and the arts of civilization have penetrated. There are many varieties, some of which are ill-flavoured.

2735. By the Hindoos the wood of the tree is consecrated to the service of the dead, and used for coffins and funeral piles. From the flour of the dried kernels several kinds of food are prepared, and the stalks are employed with the betel nut.

2736. The mango has been fruited both in France and England. *If a few worked plants* could be had from Jamaica, and a stove fitted up for them, there is little doubt, according to Mr. Knight, that the fruit might be had upon the table as easily as the pineapple.

Subsect. 4.—***Mangostan*** (*Garcinia Mangostana*).

2737. This (*fig.* 519) is one of the most delicious fruits in the world, and grows in Sumatra, Java, and other islands of the Indian Ocean. The fruit is about the size and shape of the orange, surrounded by a thin shell. The pulp is juicy, and of an exquisite flavour, partaking of that of the pineapple and strawberry, though some have compared it to other combinations of the best fruits. It is also very wholesome, and is almost the only fruit allowed to some invalids, being cooling, and a happy mixture of the tart and the sweet. The tree is about twenty feet high, and extremely beautiful.

Fig. 519.

Fig. 520.

Subsect. 5.—*Aku* (*Blighia Sapida*, H. R.).

2738. This fruit (*fig.* 520) is so named because it was carried by Capt. Bligh, in 1793, from Guinea, its native country, to Jamaica, where it now grows well, and is much esteemed. The fruit is a pome, about the size of a goose's egg, having a grateful sub-acid flavour, and being very wholesome and nutritive It has been planted in this country, and, it is thought, may, in a few years, produce fruit as easily as the orange.

Subsect. 6.—*Bread Fruit* (*Artocarpus*, Linn.).

2739. This very important fruit was originally found in the southeast parts of Asia, and the islands of the Pacific. There are two species of bread fruit, the *Artocarpus integrifolia*, with the leaves entire, which grows chiefly on the continent of Asia; and *A. incisa*, with the leaves deeply notched, which grows chiefly in the islands, and is the proper bread fruit (*fig* 521). The first is called *Jaca*, and the fruit grows to an enormous size, often to more than 30 pounds. It is eaten, but it is not very palatable. The last, the proper bread fruit tree of the South Sea, was found originally in the islands of the Indian Ocean and Southern Pacific by Dampier, in 1688: it grows to the size of a middling oak, and the fruit is about eight or nine inches long, of a yellowish-green colour, and is covered with hexagonal warts. It grows in clusters of five or six. The pulp is white, and is partly farinaceous and partly fibrous: when quite ripe it becomes yellow and juicy.

Fig. 521.

2740. *It is dressed in various ways.* When roasted or baked, they scrape off the second rind, and the interior is eaten as bread; it has no seed nor stone. Its taste is agreeably sweet, between that of wheat bread and roasted chestnuts. It is extremely nutritive, but must be eaten new, for in twenty-four hours it becomes harsh and unpalatable. When boiled it much resembles potatoes; some think it more like the Jerusalem artichoke, and others the chestnut. It is also beaten up with cocoanut and milk. The fruit is gathered before it is fully ripe, for when mature it quickly runs into decay. The bread fruit continues in season above eight months in the year; and so productive is it, that two or three trees are sufficient for the yearly support of one person: during the remaining months they make of it a sourish paste, which they keep for store.

2741. *At the expense of this government, and through the well-known exertions of Captain Bligh*, the bread fruit has been brought to the West Indies in consequence of the great expectations that had been formed of its utility; but, though it is easily cultivated, it does not appear to excel the banana. From experiments made in the West Indies, it appears that it could be converted into flour, from which cakes were made extremely

well flavoured. It is scarcely necessary to say that in this country it can only be raised in the hot-house.

SUBSECT. 7.—*The Durion* (*Durio Zibithinus*, Linn.).

2742. This is an Asiatic fruit which grows upon a lofty tree; and, though of an agreeable taste, has an unpleasant strong odour. Some of the fruits are as large as a man's head, and are covered with a kind of pointed scales. It must be eaten fresh, as it putrefies in twenty-four hours. The part which is eaten is a thick pulpy juice of the consistence of thick cream, which has the flavour of a delicate animal substance mixed with a cool vegetable acid. This singular flavour cannot be imitated by any process of cookery; and the substance is extremely nutritious. It is a costly fruit even in its native country, and is highly prized.

SUBSECT. 8.—*Guava* (*Psidium*).

2743. There are various species of the guava, some of which are natives of Asia, some of America, and some common to both. The best of these is the white guava (*Psidium pyriferum*), which is plentiful in the West Indies. The fruit is rather bigger than a hen's egg, yellow, smooth, and of a peculiar smell. The pulp is of a very agreeable taste, sweet, aromatic, and flesh-coloured. It is used at the dessert, and preserved. Guava jelly is considered as one of the finest conserves which we have from the West Indies.

SUBSECT. 9.—*The Mamma* (*Mammea Americana*).

2744. This is a native of the West Indies, where the tree grows to the height of seventy feet. The fruit is yellow, and somewhat resembling a russet apple in size and shape. The pulp is yellow, and is very fragrant and delicious, like the finest apricot.

SUBSECT. 10.—*The Litchi* (*Dimocarpus Litchi*).

2745. This is a Chinese fruit, round, and about two inches and a half in diameter. It is covered with a tough leathery coat, within which is the pulp, colourless, semi-transparent, slightly sweet, and of a very agreeable taste. It is often brought to this country in a dried state, in which, though the pulp be much diminished in size, it retains a considerable portion of its original flavour. It is not unlikely but it may become common in this country as a hot-house fruit.

SUBSECT. 11.—*Jujube* (*Zizyphus Vulgaris*, *Z. Jujuba*).

2746. This is a favourite dessert fruit in Italy and Spain, either fresh, or dried as a sweetmeat; and a pleasant pectoral lozenge is made of it by the French apothecaries. The fruit is to be seen in abundance in the markets of Constantinople and the southern parts of Europe: the Turks plant the trees round their coffee-houses, that they may enjoy both their shade and their fruit. It is found in greatest perfection in China, where there are upward of sixty species.

SUBSECT. 12.—*The Juvia* (*Bertholletia Excelsa*).

2747. This fruit is described by Humboldt as that which encloses the triangular grains imported under the name of *Brasil nuts*. The fruit itself is as large as a child's head, being covered by a shell, and growing upon a tree fifty or sixty feet high; the force of their fall is so great as to be fatal to one who might be struck with them; hence the Indians never enter the woods where they grow, in the season of fall, without covering their heads by a buckler.

SUBSECT. 13.—*Papau* (*Carica Papaya*).

2748. The papau, which resembles a gourd, about the size of an ordinary melon, grows on a branchless tree in the East and West Indies. It is cultivated, and is eaten both raw and cooked. It is wholesome, but not very palatable. It is usually gathered when half grown, and soaked in water to withdraw an acrid milk like mangoes, for which it sometimes forms a substitute. The milk of this fruit is a singular substance, for it contains a large proportion of a species of fibrin, very like that of animal flesh, and that of fungi, a circumstance which is uncommon among vegetables; and the exhalations from the leaves of the tree have so powerful an effect, that newly-killed meat suspended on the tree in a few hours becomes quite tender; and the flesh of old hogs and poultry fed upon the leaves are said to be as tender as that of young pigs and pullets.

SUBSECT. 14.—*The Alligator, or Avocado Pear* (*Laurus Persica*).

2749. This is another West Indian fruit, about the size of an apple. It is considered as one of the most delicious of fruits. It consists of a kernel enclosed in a soft rind, and the yellow pulp has the firmness and delicate flavour of the peach, but much superior.

SUBSECT. 15.—*The Anchovy Pear* (*Grias Cauliflora*).

2750. It is, likewise, one of the fruits of the West Indian islands. It much resembles the mango in taste, and when green is sometimes pickled. It might be raised in England like the pineapple.

CHAPTER X.

SPICES.

SECT. I.—GENERAL REMARKS.

2751. *All the substances classed as spices are the produce of tropical climates only;* none of our native plants, and no plants that come to maturity in the open air in this climate, possess sufficient aromatic flavour to be reckoned among the spices. The most valuable of these natural productions were originally found in the islands situated in the Indian Ocean, called the Spice Islands, or Moluccas, and were probably conveyed from them in the most distant ages. The spices which Queen Sheba presented to Solomon were unknown in Palestine, and probably came from Ceylon or some of the islands to the east.

The delicious aromatics of tropical regions were highly prized by the ancient nations; and, besides spices, we read of frankincense and myrrh, from the East, as ranking among their most esteemed luxuries. The wealthy Romans indulged in these to an extravagant degree; as navigation and the means of intercourse between distant nations improved, from the facility of transport, they found their way, as articles of traffic,

to countries very remote from the places of their production; and the inhabitants even of the northern parts of Europe shared in the advantages of this commercial spirit.

2752. *On the use of foreign spices*, we may quote Dr. Paris in his work "On Diet." "These were not," he observes, "intended by nature for the inhabitants of temperate climes: they are heating and highly stimulant. I am, however, not anxious to give more weight to this objection than it deserves. Man is no longer the child of nature, nor the passive inhabitant of any particular region: he ranges over every part of the globe, and elicits nourishment from the productions of every climate. It may be, therefore, necessary that he should accompany the ingestion of foreign aliment with foreign condiment. Nature is very kind in favouring the growth of those productions which are most likely to answer our local wants. Those climates, for instance, which engender endemic diseases are, in general, congenial to the growth of the plants that operate as antidotes to them. But if we go to the East for tea, there is no reason why we should not go to the West for sugar. The dyspeptic invalid, however, should be cautious in their use; they may afford temporary benefit at the expense of permanent mischief. It has been well said that the best quality of spices is to stimulate the appetite, and their worst to destroy, by insensible degrees, the tone of the stomach. The intrinsic goodness of meats should always be suspected when they require spicy seasoning to compensate for their natural want of sapidity."

Sect. II.—Pepper (*Piper*, Linn.).

2753. This is a well-known spice of an aromatic odour, and an extremely pungent and acrid taste.

2754. *Black Pepper* (*Piper nigrum*, Linn.) is the fruit of a species of climbing vine, a native of the East Indies, and found on the slopes of mountains in the southern parts of both peninsulas; it is also cultivated extensively in Malabar, and the eastern islands, Sumatra, Java, Borneo, and those which are near. It was formerly known only as the growth of these countries, the whole globe being supplied from them; but it has been lately introduced into Cayenne. The berries grow in spikes of from twenty to thirty, are at first green, and when ripe they are of a bright red colour. After being gathered, which they are while green, they are spread out on mats, with their skins on, and dried in the sun: thus they become black, and more or less shrivelled. Those which are least ripe, and in the fittest state for gathering, shrivel the least; but when they are more ripe, they often shrivel up entirely, or contain nothing but dust. The goodness of pepper is tried by rubbing it between the hands, and what is easily reduced to powder is unsound and bad.

2755. *White Pepper* is not the produce of a separate plant, as was once supposed, but is made from the black, by steeping it in lime and water and rubbing it between the hands till the coats come off, the powerful acrid oil residing chiefly in the skins. As it is only the best grain that will bear this operation, the white pepper is the superior kind, and fetches a higher price; it is, of course, milder than the black, and is much prized in China, but little of it is brought to England. Pepper is sometimes sold in the shops ground, and then it is often sophisticated, the black with burned bread, and the white with rice flour.

2756. Pepper is very generally employed as a condiment, and, from its promoting the secretion of the gastric juice, it aids the digestive powers of the stomach, sometimes rendered necessary in our artificial mode of living; but, even in small quantities, it is hurtful in inflammatory habits. The quantity of pepper imported into Europe is quite enormous.

2757. According to the analysis of Pelletier, pepper contains a peculiar substance called *piperina*, a concrete acrid oil, a volatile oil, starch, malic and uric acids, and lignin. The oil of pepper is too pungent to be tasted; applied to the skin, it reddens and inflames it: from which we may comprehend the effect upon the palate and stomach.

2758. *Long Pepper* is produced by a different plant (*Piper longum*), growing in the same countries. It is less aromatic than the black, but the oil is still more pungent.

2759. *Cayenne Pepper* is a very different substance, and is the most heating and stimulating spice with which we are acquainted, being extremely pungent and acrid, setting the mouth, as it were, on fire. It is powder prepared from several varieties of the capsicum, which are annual plants, natives of both the Indies, where they are used in large quantities both with vegetable and animal food, and from these countries we have borrowed their use.

There are three varieties of capsicum, all natives of tropical climates, but which have been so far naturalized in this country as to bear in the open air in summer. *Guinea pepper* (*C. annum*) was introduced into England from India so early as 1548. The plant rises about two feet, and has white flowers succeeded by pods, which, when ripe, are yellow or red. *Cherry pepper* (*C. cerasiforme*) was brought from the West Indies in 1759. It is very like the last, only its pods are generally round, like cherries. *Bell pepper* (*C. grossum*) produces the largest pods, and is, therefore, generally preferred. The pods of all these, when ripe, are extremely hot in their taste; and when in their

green state they are used as a pickle, and called *chillies* with us. When ripe, they are ground into the condiment called *Cayenne pepper*; but the best of this we have from the West Indies ready prepared, and it is made from the *C. baccatum*, or *bird pepper*, so called because much eaten by birds, as hens and turkeys, which are extremely fond of it. The East Indian Cayenne is prepared in a very careless manner, and has often a dirty brown colour. To improve the colour, by making it red, a colouring substance is sometimes added, and Accum has stated that he had detected red-lead, which is a poison. With us, capsicums, or chillies, are ripe in September or October, and the pods are easily pounded in a mortar, after being dried before the fire. They may be purchased in Covent Garden market. About one fourth their weight of salt is mixed with them in the mortar to prevent the dust getting to the eyes. Dr. Kitchener states that this is the only way to have genuine Cayenne, and that the English has a finer flavour than the foreign, though not half the heat.

2760. *This powerful spice has become a necessary article at table*, and is much esteemed for its flavour, and the quality which it is supposed to possess of promoting the digestion of fish and other kinds of food. But it may be doubtful if the practice is conducive to health; for, though Cayenne pepper, like highly-flavoured Indian soys, may occasionally assist digestion, it would, perhaps, be better that invalids should abstain from food requiring a vigorous stomach, than to employ artificial stimulants.

2761. The dish called *Man-dran* in the West Indies, which is resorted to for exciting an appetite, and which is said to be sure to do so in the most languid state of the digestive organs, is a mixture of bird pepper, shallots or onions cut small, a little lime juice, Madeira wine, and sliced cucumbers.

Sect. III.—Cinnamon (*Laurus Cinnamomum*, Linn.).

2762. This is the inner bark of a tree, a native of Ceylon, and several countries in the East, as China, Borneo, &c., but it is now cultivated in the West Indies and South America. It has also been lately planted in Egypt, and appears to succeed. The cinnamon-tree grows to the height of twenty feet; but when cultivated for the sake of the spice it is not allowed to attain its full size, but is lopped close to the ground when about ten feet high, with a stem one or two inches in diameter. New branches shoot up from the roots, and these shoots are cut when from half an inch to three quarters of an inch in thickness, and in length from two to three feet. The fragrant bark is protected by a tasteless cuticle, and after this is stripped off the bark is dried, which makes it shrivel up and assume the quill form in which it is imported, and the smaller pieces are put within the larger. The best is scarcely thicker than paper, and in long pieces, of a light yellow, bordering upon fawn brown, a dark colour being a mark of inferiority. Its odour is very fragrant; its taste is agreeable and highly aromatic, hot, but not too pungent to be borne upon the tongue, and without any bitterness.

2763. Cinnamon easily communicates its agreeable flavour to any other substance, and hence it is much employed in the most delicate preparations of the cook and confectioner.

2764. An essential oil is distilled from it in the countries where it grows; but very little of this is contained in the bark as we have it. This oil is very pungent, and is heavier than water; it is extremely dear. The best cinnamon comes from Ceylon, where a greater quantity grows than in any other part of the world; and the property of all the cinnamon-trees there is retained by our government, though the regulations by which the preparation of their produce for market was limited and restricted are now relaxed: some of the Chinese is also very good, but generally it is inferior; the Cayenne is thicker, but not so good; that from Brazil is the worst.

2765. *Cassia is a bark* brought chiefly from China and Ceylon, possessed of the usual properties of cinnamon, and was once supposed to be the produce of another tree; but it is now certain, from the observations of Mr. Marshall, that it is only the bark from the trunk and larger branches of the cinnamon-tree: it is of a flat shape, much thicker, and has the mucous integument of the bark remaining, which is cleared off from the proper cinnamon. It has the same qualities of cinnamon, only in an inferior degree. According to Vauquelin, cinnamon contains volatile oil, tannin, mucilage, a vegeto-animal colouring matter, an acid, and woody fibre. The oil of cinnamon is prepared chiefly from cassia and from the chips of cinnamon: eighty pounds yield about two ounces and a half of the oil, worth in England a guinea per ounce.

Sect. IV.—Cloves (*Eugenia Caryophillata*).

2766. Cloves are the fruit, or, rather, the calyx of the unexpanded flowers of the clove-tree. Their name in French is *clou*, a nail, from their resemblance to one, and hence our term "clove."

2767. The tree is a native of the Malacca Islands, where they were originally found by the Portuguese in 1511, the date of their introduction into Europe. The Dutch, on gaining possession of the Spice Islands, endeavoured to secure a monopoly of cloves; and with the view of confining the cultivation of the tree to Amboyna, the seat of their power, they bribed the surrounding chiefs to cut down all the clove-trees in the other

islands. As these contracts still exist, a military officer with a party of soldiers annually visit every place with axes to destroy the young trees, which spring up in astonishing abundance. Sir Stamford Raffles describes the clove as a tree of noble height, somewhat like the bay, and composing, by the beauty of their form, the luxuriance of their foliage, and the spicy fragrance with which they perfume the air, some of the most delightful objects in the world. The best variety of the Amboyna clove, called the *royal clove*, is scarce. It is smaller and blacker than the other kinds.

2768. But, notwithstanding this conduct of the Dutch, cloves are now cultivated in other parts of the world. The French introduced them at Mauritius, Bourbon, Cayenne, and Martinique, and they have since been carried to St. Kitt's, St. Vincent's, and Trinidad. The trees live twenty-four years, and bear from six to twenty years. After the cloves are collected in the green state, they are dried quickly by exposure to heat and smoke, until they appear of a deep brown colour; after which the drying is completed in the sun. Those dried wholly in the sun are the best.

2769. *Cloves form one of the most agreeable of all the spices*, and are much employed in flavouring many dishes, preserves, liqueurs, &c. They contain a considerable quantity of essential oil of a very pungent quality, in which their efficiency consists, and this is procured by distillation; it is said that the Dutch sometimes extract part of this oil, and then mix the deteriorated cloves with fresh ones, from which they imbibe some of what they contain. Cloves are also very liable to imbibe water, which increases their weight.

2770. *Cloves are employed* more for their flavour than for their medicinal qualities; but they are likewise very powerful stimulants of the stomach, and are used, but with caution, in conjunction with bitters. They yield their medicinal and other qualities to water and to alcohol.

2771. *According to Tromsdorff*, 1000 *parts of cloves contain* 180 of volatile oil; 40 extract scarcely soluble; 130 gum; 60 resin; 280 woody fibre; and 180 water. The volatile oil of cloves might be advantageously employed instead of the dried clove in culinary processes.

Sect. V.—nutmeg (*Myristica Moschata*).

2772. This is also a native of the Spice Islands, the Moluccas, and the monopolizing spirit of the Dutch was long enabled to keep the cultivation of it to themselves by extirpating it from all the islands except Banda, where it is chifly grown, the whole of the plantations being in the possession of their government. But while the English had possession of the Spice Islands, plants were carried to Penang and Bencoolen, where they now flourish, and produce a considerable quantity of nutmegs. Sir Stamford Raffles states that they are also largely cultivated in Sumatra. Attempts have likewise been made to introduce them into the West Indies, not altogether without success. The tree is not unlike the pear. It bears fruit all the year round.

2773. *The exterior part of the fruit is a pulpy substance*, sometimes brought to table in India as a preserve; within this is a thin shining black shell surrounded by membranous layers, which constitute another of our spices, the *Mace*, and within the shell is the nutmeg. To prepare them, the pulp is cleared off, and the mace separated by a knife; the nuts are then dried in the sun, and afterward by the fire; by this the shell becomes brittle, and the kernel within shrinks, which admits of the nuts being broken without injuring the nutmeg. They are then soaked in sea water, and impregnated with lime to destroy the vegetating power and keep away insects; but Mr. Crawford observes that the natives, if left to themselves, transport them in the shell, which is by far the best mode.

2774. *There are two sorts of nutmeg*; one wild, which is long or oval-shaped, and much inferior: the cultivated nutmeg is nearly round: the best are firm, hard, and of an unctuous consistence, the odour strong, aromatic, and agreeable; taste hot and acrid. When cut across, they appear full of dark veins, which contain much volatile oil.

2775. *This oil is yielded by distillation*, and it possesses the flavour of the nutmeg in perfection, two drops being nearly equal to a pound of the powder; this is made from the broken kernels; and it is said that the nutmegs are sometimes punctured and boiled for the purpose of extracting the oil, the holes being filled up with sassafras: it is one of the few oils of tropical climates that are lighter than water. It is employed in medicine.

2776. *The nutmeg is much used as a condiment*; but Dr. A. Thomson observes that, if taken in large quantity, it is found to have narcotic effects, and to produce symptoms indicating great determination to the head, on which account it should be cautiously used in apoplectic and paralytic habits.

2777. *The analysis of M. Bonastre shows nutmeg to contain*, in 100 parts, 24 of an insoluble white matter (stearin); 7·6 of an insoluble coloured butter (elain); 6·2 of a volatile oil; 0·6 of an acid; 2·4 of fecula; 1·2 of gum; and 58·0 of ligneous matter.

Sect. VI.—mace.

2778. *Mace is the reddish membrane surrounding the shell which contains the nutmeg.* It

is dried previous to packing tight in bags. Its general qualities are the same as those of nutmeg; it has an agreeable aromatic odour, and a hot, biting taste. According to Mr. Henry, it contains a small quantity of volatile oil; a large quantity of a yellow, odorous, fixed oil, soluble in ether, but insoluble even in boiling achohol; a nearly equal quantity of a red, odorous, fixed oil, soluble both in ether and alcohol; a gummy matter forming nearly a third of the weight of the mace; and a small quantity of woody matter.

SECT. VII.—GINGER (*Zingiber Officinale*, Linn.).

2779. Ginger is the tuber, or, rather, the rhizome, of a plant which is a native of the mountain of Gingi in Hindostan, whence the name. It was carried from India to Cayenne and the West Indies, where the greatest part of the ginger of Europe is cultivated. There are two kinds of ginger, but the difference consists chiefly in the mode of preparing it. *White* ginger consists of the best pieces, of which the outer skin has been scraped off; they are then well washed and dried in the sun: it breaks with a fibrous fracture, and is the strongest and best flavoured: good ginger should be compact and heavy. *Black* ginger is the inferior kind, which has only been scalded before it was dried.

2780. Ginger is one of the most agreeable and wholesome spices: it is much used in culinary operations, and likewise in beer and other beverages. It is stimulating to the digestive organs, and is less hurtful than pepper; but, like all excitants, it should be used with great moderation. The constant use of any kind of spices is, as we have stated, to lessen in time the nervous irritability and weaken the digestive function; for this reason, gingerbread, which contains a great deal of ginger, is very injurious to the stomachs of children. As a medicine it is occasionally highly useful; and an essence or essential oil of ginger is prepared as a more convenient mode of applying it.

2781. *Preserved ginger* comes to us from the West Indies. It is made by scalding the roots when they are green and full of sap; then peeling them in cold water, and putting them into jars with a rich sirup, in which state we receive them. It should be chosen of a bright yellow colour, with a little transparency: what is dark-coloured, fibrous, and stringy is not good.

Ginger roots, fit for preserving, and in size equal to West Indian, have been produced in the Royal Caledonian Horticultural Garden in Edinburgh.

When analyzed, ginger is found to consist chiefly of starch; besides which it contains a resin soluble in ether, another insoluble, a volatile oil, a vegeto-amimal matter, acetic acid, potash, gum, sulphur, and lignin. The pungency consists in the oleo-resin combined with the starch.

SECT. VIII.—ALLSPICE, PIMENTO, OR JAMAICA PEPPER (*Eugenia Pimenta*, Linn.).

2782. This well-known and useful spice is the berry of a handsome tree that grows to the height of twenty feet in the West Indies and South America. It belongs to the natural order of the Myrtaceæ, and as it grows spontaneously in Jamaica, the seeds are supposed to be sown by birds. The fruit is not suffered to ripen, but is gathered while yet green; when dried in the sun it becomes black. It is less expensive than the Oriental spices, and, as it combines the flavour of cinnamon, nutmeg, and cloves, it is known here popularly by the name of *allspice*. It is a very agreeable aromatic, and is considered as the most mild and innocent of the common spices; hence it is much employed for domestic purposes.

Its active principle resides in an essential oil, which it gives out readily to water and spirit. The essential oil, or essence of allspice, is of a deep reddish-brown colour, and extremely pungent; a few drops is sufficient to give a flavour to gravy, or to mulled wine.

The best pimento is from Jamaica; an inferior and larger kind grows in Tobago.

It may be proper to observe that it is the practice of London shops to sell what they call *mixed spice*, which consists of a portion of all the above-mentioned spices ground together; this is much used about Christmas time, and is convenient for many purposes.

SECT. IX.—LEMON AND ORANGE PEEL.

2783. *Among the aromatic condiments may likewise be reckoned the rinds of the lemon and orange*, called lemon and orange peel, which owe their high flavour to the essential oil they contain, which is extracted and sold as the essence of lemons and oranges; a few drops of this essential oil is equally efficacious with the peel itself, and has the advantage of being easily preserved, whereas the peel, when dried, loses most of its flavour in time, from the essential oil escaping.

BOOK VIII.

ON THE VARIOUS BEVERAGES USED IN THE BRITISH ISLES.

CHAPTER I.

WATER.

Sect. I—INTRODUCTORY OBSERVATIONS.

2784. In the following account of water, we propose to confine ourselves chiefly to the consideration of those properties which relate to its use as a beverage, either alone, or as an ingredient in the preparation of the various kinds of drink which we shall describe; and to its employment in the culinary art.

2785. *As a beverage, the qualities of water differ materially*; every one is sensible of the great difference between that of a soft and clear spring, and that of a stagnant pool; and persons much accustomed to this simple beverage can distinguish flavours in it which are not sensible to others. The value of purity in water is universally admitted, but it requires to be explained in what that purity consists; for it can be shown that water absolutely pure is not the fittest for many purposes. All water, in a natural state, is impregnated with a certain proportion of air, which is highly useful; and of many other substances found more or less in water, some are harmless, while others are extremely prejudicial.

2786. *The most general distinction of water is into hard and soft*, and both the cook and the laundress may practically be good judges of these properties; yet we do not consider it sufficient to possess this merely practical knowledge; we shall therefore enter more minutely into the natural history and details respecting a liquid in such universal use, and of such serious importance to the health and comfort of families.

2787. With this view, we propose first to inquire into the chemical nature of water as a liquid body, and we will afterward examine the properties of the several kinds which are obtained from different sources, and which are found in various situations in the earth; to which will be added instructions as to the best modes of supplying and preserving it.

Sect. II.—OF THE COMPOSITION AND GENERAL PROPERTIES OF WATER.

2788. In order to have a clear idea of the nature of water, we must take a view of its *chemical constitution*.

2789. *Water was long considered as one of the natural elements*, and, consequently, was supposed to be simple, and incapable of being decomposed, or separated into other substances. The discoveries of chemistry, however, have proved that this fluid is, in fact, a chemical combination of two kinds of gas, or air, which, of themselves, are invisible. The nature of these gases has been mentioned in Book III., "On Ventilation;" but as a certain degree of repetition is unavoidable in a work like the present, it will be proper to speak of them again as the elements of water.

2790. *The two gases of which water is composed are oxygen and hydrogen.* Oxygen is that gas which we formerly stated to enter into the composition of the atmosphere which we breathe, and without which, indeed, life could not be supported; hydrogen is an inflammable body, and is the basis of the gas now so much employed in lighting our streets. But water is *not a mere mechanical mixture* of these two kinds of air, for if a portion of each of them be merely introduced into one vessel, water will not be the result. In order to produce the fluid we are treating of, these gases must be *united* in what is termed a *chemical* mode, that is, by a particular and intimate union very different from simple mixture. There is no doubt that water is thus formed daily by many natural processes, some of which are connected with meteorological phenomena. The fact of the composition of water was first shown by Mr. Cavendish, who demonstrated it by *burning* oxygen and hydrogen gases in a dry glass vessel, by which a quantity of pure water was generated exactly equal in weight to that of the gases which had disappeared.

2791. *By ingenious experiments, water can be separated into its elementary constituents*, oxygen and hydrogen; and by another process these very constituents can be made to re-unite, and form the same quantity of water as was decomposed. There is, therefore, no opinion in natural philosophy better established than that water is a compound body, and, consequently, that it cannot be ranked among the elements.

When we speak of the general properties of water as a body, we allude only to water which is absolutely pure, and unmixed with any other matter whatever.

2792. *Although pure water is composed of two gaseous bodies, yet there is no variety in its composition*; that is, a given quantity of water has not at one time more oxygen, and at another more hydrogen, but the proportion of these constituents is always precisely the same, namely, eight parts, by weight, of oxygen, and one of hydrogen. Neither is pure

water, in itself, liable to any change whatever; when its elements have once fairly united to form a liquid, they cannot be separated or altered in any manner without the liquid entirely losing all its properties; in short, by no longer existing as water. Why, then, it may be asked, do we hear of different kinds of water? If water be unchangeable, what distinctions can be made, or how can various specimens of water have different qualities, as hard, soft, and so on? The answer to these questions will form the subject of the following pages. And first we shall describe the properties of water as a body, independently of every kind of mixture with any other substance, or contaminations of any kind.

2793. *Water is volatile*, that is, it is capable of being converted into vapour. If a vessel containing water be exposed to the air, the water gradually lessens in quantity, and, at length, disappears altogether. This, in familiar language, is said to be the *drying up* of the water; but the fact is, the water has insensibly been converted into invisible vapour, which has mingled with the atmosphere. This is called *evaporation;* not a particle of the water is lost, but the whole has dissolved in the air, to return one day in the form of rain.

2794. *We have already shown* (in Chap. I., Book I., "On Heat") that water boils, or is converted into steam, when it is heated to 212° in the ordinary pressure of the atmosphere, that is, when the barometer stands at 30 inches; water cannot be made any hotter in open vessels, because the steam carries off the heat. If salt be added to water, it is capable of being heated to a degree higher than 212°, in proportion to the strength of the brine.

2795. *But water may be heated to a much higher degree in closed vessels*, where the steam is confined so as to exert a great pressure upon the surface of the water; or the steam may thus be prevented from forming; but in that case it is requisite that the vessels should be extremely strong, or have a safety-valve, otherwise there is danger of their bursting. The digesters for dissolving meat and bones are made upon this principle.

2796. We may here refer the reader to what we have said in Chap. I., Book I., "On Heat," for many details connected with the heating of water.

2797. *Steam is condensed again into water by cold:* if deprived of the heat which made it steam, it returns to its former liquid state. On these two processes, the conversion of liquids into the elastic form, and condensing them by means of cold into the liquid form again, the *art of distilling* depends.

2798. *Water is so bad a conductor of heat* that it was supposed by Count Rumford to be absolutely a *non-conductor*. And although late experiments have shown that this is not actually the case, yet water conducts heat so imperfectly that the count's conclusion may be taken as true for practice in the greater number of ordinary cases. A vessel of water, when put upon the fire, is heated by the lower stratum of water expanding, and becoming specifically lighter; hence it ascends through the rest to the top, causing another layer to take its place; this becomes heated in its turn, and so the various particles of water *transport* or *carry* the heat upward by their motion.

2799. *Water becomes solid, or is converted into ice*, when it is cooled down to 32°, and the ice begins to be formed by appearing like needles crossing each other. In freezing, the air contained in water is excluded, but the bulk of the ice being greater than that of the water which has been frozen, ice is specifically lighter than water, and swims upon it. The specific gravity of ice is about 0·94; that is, it is $\frac{6}{100}$ lighter than water.

2800. *Water, in freezing, and increasing in bulk, expands with great force;* and hence it frequently bursts very strong vessels in which it may be contained: to this cause must be attributed the rupture of pipes in frosty weather. The expansive force of ice in freezing is well shown in an experiment made by Major Williams. A bomb-shell, thirteen inches in diameter, and more than two inches thick, was filled with water, and the fuse-hole plugged up with an iron bolt: thus charged, it was exposed to the cold of a severe frost, and the consequence was that the bomb burst by the congelation of the water. This expansive power of water in freezing is of infinite importance in the preparation of soils by the disintegration of rocks, and the pulverization of the ground after it has been turned up.

2801. *Water assumes the solid form*, not only when it becomes ice, but likewise in many cases where it combines chemically with other bodies; for instance, when salts crystallize from their solutions in water, a certain portion of this fluid becomes fixed, and is called *the water of crystallization:* a familiar example of this may be given in the slacking of lime, where the water becomes united to the lime, and a dry powder, called *slacked lime*, is the result, and which always contains some water in a state of solidity: this kind of union of a substance with water is called by chemists a *hydrate*.

2802. *That all water which has been exposed to the atmosphere contains a portion of air*, which it has absorbed, may be shown by placing this fluid under the receiver of an air-pump and exhausting it; the air will be seen coming out of the water in numerous bubbles. But this air may also be driven out by boiling; for this purpose the water should be boiled for two hours, and if such boiled water be again exposed it will absorb air as before. About 100 cubical inches of spring water afforded two cubical inches of

air, which consisted of ten per cent. of carbonic acid, and the rest atmospheric air, that is oxygen and nitrogen; but different springs vary considerably in the quantity of air which they contain.

Rain water contains usually 3·5 per cent. of air, and 1 per cent. of carbonic acid gas. Snow water, when fresh, has no air.

2803. *Water absorbs various gases in different proportions.* Of some of the acid gases it takes up several times its own volume.

2804. *Water is susceptible of compression*, though in a very small degree. It was formerly thought to be absolutely incompressible; and it may be still considered so for all practical purposes; but it was shown long ago by Mr. Canton, and more lately by Mr. Perkins, that it can be compressed in a small degree by applying a very great force: it has been calculated that, by a pressure equal to 2000 atmospheres, it may be diminished $\frac{1}{12}$ part of its bulk, though Œrsted considers this estimate as somewhat too great.

2805. *Water is the most convenient material to serve as a standard for comparing the weights of other substances*, and their weight, compared with an equal bulk of water, is termed their *specific gravity*; therefore, in making tables of the specific gravity of various substances, water stands as 1·000. As water expands with heat, and contracts with cold, the weight of a cubic foot, or any other measure of water, must be somewhat less in warm weather than in cold; and on this account, when it is spoken of as a standard, it is always supposed to be of a certain fixed temperature. By very accurate experiments made lately, in consequence of the act of Parliament to regulate weights and measures, it has been ascertained that a cubic inch of distilled water at the temperature of 62°, barometer 30 inches, weighs 252·458 grains. An imperial pint, at the same temperature and state of the barometer, weighs twenty ounces avoirdupois. Any water heavier than this must contain some other substances, and, consequently, be less pure. Water is 816 times heavier than atmospheric air.

2806. *Water is a very powerful solvent;* hence it is very important, both as a natural agent, and in a great number of processes. Substances are remarkably distinguished as they are soluble, or not, in water. Frequent mention of the solubility or insolubility of substances in water will be found throughout this work.

2807. *Water absolutely pure is, perhaps, never found in nature.* It is nearly so in many instances; but in consequence of its being a powerful solvent, it soon becomes contaminated, more or less, by foreign substances. The purest water that can be found in a natural state is obtained by melting snow that has just fallen in a clean vessel at a distance from buildings, or by collecting rain water in very clean vessels at a distance from houses. But the chemist finds that, even then, the water is not absolutely pure; it has received, although in a very minute quantity, some adventitious matter in falling through the atmosphere; and it contains a portion of air, which may be separated by the air-pump. All the varieties of water which are found on the surface of the earth, or rising in the form of springs, are, as we might expect, still more impure, containing various substances which the water has dissolved. It is by art alone that we can obtain the purest water: to procure it we must employ distillation.

2808. *Distilled water is the purest state in which we know this fluid.* When heat is applied, the pure water alone rises in the form of steam, and the salts, and all other substances, dissolved in it, sometimes in very minute quantity, will not rise with the vapour, but remain behind; and thus distillation enables us to free water from any contamination by other matters which it may contain.

The process of distillation effects no change whatever in the water itself; it merely separates the pure fluid from its impurities. Water, when distilled, is quite colourless, beautifully transparent, entirely void of taste and smell, and it is lighter than any other water. It is perfectly soft; soap dissolves in it completely, presenting an opaline appearance.

2809. *Distilled water is absolutely unchangeable.* Time has no effect upon it, if kept ever so long. Notwithstanding its purity, however, it is little used except for medical purposes, or in experiments, partly on account of the trouble of preparing it, and partly because the process of distillation deprives it of the air which water always has in a natural state, and which is essential to its being an agreeable beverage: for want of this air, the taste of distilled water is vapid, although it is stated by some physicians to be an excellent solvent of the food.

In places where no water can be procured but which contains too much salts to be proper for drink, recourse may be had to distillation; but then it will be proper to suffer the distilled water to be exposed to the air for several days before it is used, and to agitate it by pouring it several times from one vessel to another, to facilitate the absorption of common air, and restore its usual taste.

The purest distilled water is obtained from rain water, and when it is required to have it absolutely pure for pharmacy, or very nice experiments, it is usual to employ glass or silver vessels for the distillation. But this nicety is not necessary for ordinary occasions: any tin kettle fitted up as a still will do sufficiently well, and any one at all acquainted with the subject may easily contrive a method of having a constant supply

of distilled water sufficiently pure by means of the common kitchen fire. This would be extremely easy in a kitchen where a boiler is attached to a range or grate; for it would only require to have a pipe from the top of the boiler leading to a worm placed in any convenient situation, and passing through a tub or cask of cold water, which must be removed when it gets too warm.

Distilled water is absolutely necessary in the composition of medicines, since impurities which might be of no detriment to water for ordinary purposes might destroy or injure the properties of certain materials in pharmaceutical preparations: hence, in the "Pharmacopœia," apothecaries are requested to use only distilled water. When the water to be distilled contains carbonic acid, if the temperature be low, a small portion of this gas passes over with the steam, and is found in the water when condensed, a circumstance which would be injurious in medicines: for instance, if distilled water were used, as it always ought, for diluting solutions of subacetate of lead, or, as it is called, sugar of lead, a cloudy precipitate would be seen, owing to the formation of carbonate of lead, which would render this preparation less effective as a lotion; but if distilled water, perfectly pure, be employed, no such precipitate occurs. This is the reason why the apothecary throws away the first tenth of the product in distillation; but for the purposes of drink, this very minute portion of carbonic acid would be no detriment whatever. The distillation should not be carried on till all the water in the still be driven off, because, when it is reduced to within about four tenths, a decomposition of the substances left is apt to take place, and a disagreeable taste communicated to the product, which would defeat the desired object.

2810. *Water, in the ordinary state, contains*, besides common air, a small quantity of another gas, the carbonic acid gas, which we also mentioned under "Ventilation," and which we shall again have occasion to speak of under "Fermentation." This gas, which assists in giving a brisk taste to spring water, distillation drives off; and this is likewise restored by exposure for a short time.

SECT. III.—RAIN WATER.

2811. *Rain water is the next in purity to distilled water*: and it is the purest, and, of course, the softest, of any natural water.

2812. *The origin of rain* is water which is evaporated from the sea and land. By the heat of the sun this liquid rises in vapour, and after ascending to the higher regions of the atmosphere, where constant cold prevails, it is condensed into mist, which appears to us as clouds; these float in the air as long as the temperature remains the same, but when they enter currents of colder wind, or are affected by electricity, they are farther condensed into minute drops of water, which ultimately unite together and descend as rain. One might expect that rain water, falling immediately from the clouds, should be absolutely pure, and entirely free from all other matter. This, however, is not exactly the case. It always contains a certain proportion of common air and of carbonic acid gas, which, however, are useful, and, as we have stated above, are the cause of its agreeable taste. But rain water, even when collected with the utmost care, is said by chemists sometimes also to exhibit traces, though very slight, of muriatic and nitric acids, together with carbonate of ammonia.

A small quantity of carbonic acid being a component of the atmosphere, its absorption by rain is easily conceived; but it is not so easy to account for the existence in it of the other acids. Rain, also, falling through the atmosphere of a smoky town, collects in its descent some impregnation from the impurities in the air above the houses. The quantity, however, of all these deteriorating matters is exceedingly small when it has been properly corrected; they can only be detected by the most delicate chemical tests, and are too insignificant to be regarded in employing rain water for the ordinary purposes of life, when used fresh; yet they are often sufficient to render it liable to spontaneous change when long kept.

From the great purity of rain water, its solvent powers are greater than those of any other natural water; hence it soon becomes impregnated with whatever matter it meets with that is at all soluble in it. In hot climates it is apt to become full of animalculæ, and at last to acquire a strong putrid smell from the decay of the animal and vegetable substances contained in it. If properly collected in this climate, however, it keeps a long time.

2813. *To obtain rain water in a state of complete purity for the purpose of examining it*, it should be collected in wide vessels perfectly clean, placed in some open space as far as possible from the smoke of towns, where they can receive the rain immediately from the clouds without its being suffered to fall upon or touch any other substance. Whatever is collected from ordinary roofs is more or less contaminated with whatever happens to be loose, and there is generally some soot from the smoke of chimneys, and fragments of loose mortar, together with a variety of matters that have been blown there by the wind. These materials, however, are not of such a nature as to make the water hard; and provided the roofs are kept clean, it will be perfectly soft, and, if suffered to settle, and filtered, will be nearly as pure as that which is collected immediately from

atmosphere. In countries or districts where water cannot be had from springs or any other source, large roofs are constructed purposely for collecting it. But the substance of which roofs consist is important to consider in collecting water from them; those which consist of lead, copper, or zinc are altogether improper, as the water would certainly be impregnated with the oxydes of these metals, and rain water in particular is found to exert a solvent power on metallic lead. In tiled roofs, where there is a great deal of mortar, the water from them frequently has some impregnation of lime, not, however, sufficient to deteriorate it to any considerable degree, except while the roof is new: wood is also improper. Slate is quite insoluble in water, and, in that case, there being generally no mortar, the water will receive no impregnation, except what may arise from smoke and dust, or what may be produced by the lead gutters and pipes, if there are any. Dripping eaves, and earthen-ware pipes placed below them, are most to be recommended where it is wished to collect water from roofs; and cisterns or tanks formed of slate, stone, or brick, covered with cement or stucco, are better to keep it than wood; lead is particularly improper. It would be very easy to construct cisterns with filters so contrived that rain water might at all times be drawn from them in a state of great purity; and in this manner almost every house, at least in the country, might be supplied with the very best and purest soft water. It has been calculated that the average quantity of water which falls in a square yard of surface in Britain, in the course of a year, is 126 gallons. If, therefore, there be 100 square yards of roofing, it will give 12,600 gallons, which would be an ample supply for all the purposes of a small family.

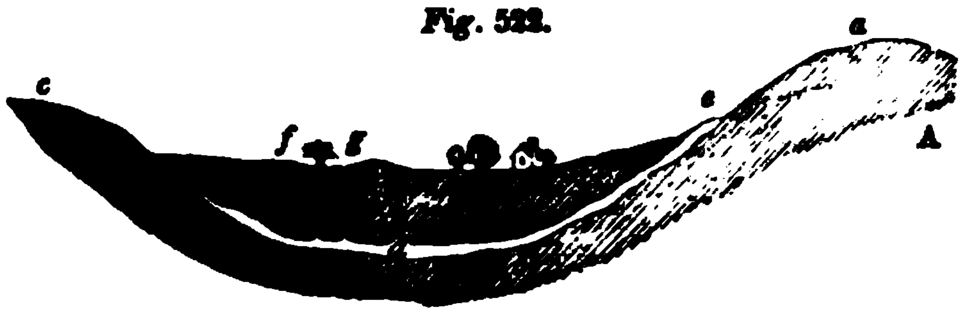
2814. *Rain water, carefully collected and filtered, is extremely agreeable to the palate, and perfectly wholesome.* From its great softness, it is also particularly fitted for the purposes of the laundress. For the mode of preserving it, see Section 10, "Filtration," and Section 12, "Cisterns and Tanks."

Sect. IV.—Spring Water.

2815. *The original source of all spring water is rain*, which, falling upon high ground, filters through the soil and the strata of the earth so long as they are porous, until it is stopped by some impervious substance, as rock, or tough clay; it will then find its way along the surface of this bed, until it arrive at some crevice or opening, through which it forces its way out on the surface. From this description of springs, it is obvious that the water which they afford would be equally pure with rain water, provided it does not meet with any substances in its passage through the earth which it can dissolve.

2816. *This will be rendered more clear if we consider the accompanying diagram.* Suppose A to be high ground, perhaps rocky, or, at least, impervious to water, and let *a b c* (*fig.* 522) represent the surface of this *impervious* stratum, having a stratum of sand, or some *pervious* substance, *d*, lying upon it; and over this let another *impervious* bed, *k*, cover the last. The rain which falls on the surface of the high ground at *a* will run down the slope of the hill until it comes to the sandy stratum at *e*, and it will sink down into the sand, and make its way to the lowest part of the sandy stratum. If there should happen to be fissures at *f* and *g* in the upper impervious stratum *k*, the water which entered at *e*, and went down to *d*, will be forced up through these fissures, because *e* is at a higher level; and it will issue out on the surface of the ground at *f* and *g* in the shape of springs. This is the origin of springs in general; they are the openings through which water is forced that has come originally from some higher ground, and made its way through the soft strata as it would through pipes; and very often the sources of springs lie at a very great distance. But if the rain water was ever so pure at first, in passing through various parts beneath the surface of the earth, where a variety of soluble salts occur, it must frequently dissolve some of them in its passage, and issue more or less impregnated; and the kind of salts and quantity of the impregnation must vary in every locality. Accordingly, spring water is never perfectly pure, nor entirely free from substances dissolved in it, though sometimes the quantity of dissolved matter may be very small, and not so much as sensibly to deteriorate its qualities with reference to domestic purposes.

Fig. 522.



2817. *The salts most frequently found in the water of springs* are sulphate of lime and carbonate of lime; but, besides these, there occur occasionally sulphate of magnesia, or Epsom salt, sulphate of soda, or Glauber's salt, muriate of soda, or common salt, now called chloride of sodium. Alum is sometimes found, though much more rarely; and salts of iron are extremely common, besides occasionally other substances.

2818. *The chief practical distinction in water is its being what is called hard and soft*, qualities which are pointed out by its action on soap. In water perfectly soft, soap dissolves without curdling, and washes with a lather; hard water curdles the soap, instead of dissolving it, and will not do for washing. This distinction is practically so important that it is necessary to explain it clearly.

2819. *What is called the hardness of water*, exhibited in its curdling soap, is owing to its containing a small quantity of certain neutral salts in solution, which have been derived from the passage of the water through the earth, for rain water is quite free from them. These salts, as has been stated, vary in their nature and proportions according to the nature of the earth through which the water has passed; but all these salts which have been just enumerated consist of an *acid* united to some other substance. Sulphate of lime consists of sulphuric acid and lime; carbonate of lime, of carbonic acid and lime; sulphate of magnesia, of sulphuric acid and magnesia; sulphate of soda, of sulphuric acid and soda; muriate of soda, of muriatic acid and soda, &c.

2820. *Now the reason why water that contains these salts curdles soap is this:* Soap consists of alkali, and oil or tallow, and it is the alkali which is the effective material in washing; but the acid of the salts dissolved in the water *decomposes the soap* by having a stronger attraction for its alkali than for the substance with which this alkali is already united, and thus the soap is rendered quite useless and ineffective. *But to make this still more plain*, we shall take a particular salt, and examine in detail what effect it actually produced upon the soap. Sulphate of lime is by far the most general cause of the hardness of ordinary spring water, except it be brackish, and then the salt would be muriate of soda. Sulphate of lime, we have said, consists of sulphuric acid and lime; and soap, we have stated, consists of alkali, either soda or potash, and oil or fat; these two, the alkali and fat, unite to form soap, which is soluble in water, although fat, one of its ingredients, is insoluble. Now, when sulphate of lime dissolved in water comes in contact with soap, the sulphuric acid, having a stronger attraction for the alkali of the soap than it has for its own lime, lets go the lime, and seizes upon the alkali; in consequence of which the fat of the soap is set at liberty. The soap is thus evidently separated into its original constituents, fat and alkali, and is, therefore, no longer soap. The soda of the soap joins to the sulphuric acid, and forms sulphate of soda, and the lime and the fat unite as an insoluble compound, appearing like a curd; in consequence of this the peculiar action of the soap is totally prevented. *And to understand this clearly, let us examine what is this peculiar action of soap.*

2821. *The action of soap is detersive*, that is, it destroys grease, which is only another term for oil or fat of some kind; and the following is the manner in which it takes away or discharges grease: the alkali of the soap unites with the grease, and makes more soap, which, being soluble in water, is thus carried off. But it may be asked, if the alkali of the soap be already united to oil or grease, why should it unite to the grease which it is intended to destroy? The fact is, that if there was a sufficient quantity of oil in the soap to *saturate* it *completely*, it would not act in this manner, and would not be detersive; but in the manufacture of soap, care is taken to have a little less oil than would be sufficient for that purpose, and therefore the alkali can still take up a small additional quantity of oil, which is just what happens in its removing grease in washing. Another question will now naturally occur to one who reflects: if the alkali of the soap be the only effective material, *why not use it by itself?* why make it into soap at all? This is done merely for convenience; if the alkali alone was rubbed upon the linen, it would, as every laundress well knows, burn and corrode it, and it would also corrode the skin of the hands: uniting it to fat, therefore, in making it up into soap, is for the purpose of moderating its strength, and enabling it to be applied for a greater length of time to the desired parts, instead of being, as it would be in the state of soda only, soon lost in the water. It follows from this explanation that the strongest soap has the greatest quantity of alkali.

We must observe that water never contains so much sulphate of lime as to be perfectly hard, or to destroy altogether the action of soap; therefore we find water *more or less* hard; and to a certain extent it may do for washing, though badly.

2822. *Carbonate of lime is another substance very commonly dissolved in water*, and which occasions hardness, as well as being otherwise inconvenient and prejudicial. Carbonate of lime is composed of lime united to carbonic acid, which has been described when treating of "Combustion," Book II., Chap. II.

2823. Common carbonate of lime *not being soluble* in water, it is natural that one should inquire how it can be occasionally held in solution in that fluid? That the carbonate of lime in hard water is dissolved is evident, since water of this kind is perfectly transparent, and not cloudy, as if chalk were mixed with it. It is not possible to account for this circumstance, nor to explain distinctly the mode of remedying this defect in water by depriving it of its carbonate of lime, without entering into the following details, which, although a chemical subject, we shall endeavour to render very simple, at the same time recommending every one to cultivate chemistry so far, at least, as to be able to understand explanations of this nature: a task which is far from being difficult, and perfectly within the easy attainment of every person who has had the advantage of a liberal, or even an ordinary education.

2824. Every kind of limestone or carbonate of lime, of which chalk is one, is *insoluble* in pure water; therefore pure water, running over chalk or other limestone rocks, cannot be impregnated with lime. Were not this the case, we should have no water free

from this earth, as it is so abundant in nature; nor should we have springs of water issuing so pure as they do frequently from chalk rocks. But springs of natural water are often impregnated with carbonic acid, which they receive in the earth by means not well understood; the fact, however, is certain; and when such water is exposed to the air, but still more when boiled, the acid gas flies off, and leaves the water free. Now, common carbonate of lime, as, for instance, chalk, is, as we observed, united to carbonic acid, but to a certain determinate proportion only of this acid; it cannot take up any more as common carbonate: no chalk or limestone contains more than this fixed quantity; and we have said that in this condition it is not soluble in water. But, if common carbonate of lime should meet with water holding carbonic acid without lime, the lime of the carbonate will then receive an additional quantity of the acid gas, and thus become *doubly carbonated*, or what is called a *bi-carbonate*, or, as some say, a *super-carbonate*; and this *bi-carbonate of lime is soluble in water*.

2825. Upon these facts the explanation of the phenomenon in question depends. In order that water should have carbonate of lime in solution, it must first have been impregnated, by some means or other, with carbonic acid: how that has happened we cannot always say: we know that this gas issues in abundance from the interior of the earth, as in the case of the famous *Grotte del Cane*, and numberless other instances. Water greedily absorbs this gas, and by its means, in the way just mentioned, it is rendered capable of holding abundance of lime in solution. But what will be the natural consequence of exposing such water, now impregnated with lime, to the air, and, still more, of boiling it? We have said that the carbonic acid will be driven off by exposure; that is, *so much* carbonic acid as was sufficient to convert the common carbonate of lime into bi-carbonate of lime, *but no more*. By boiling, therefore, the bi-carbonate is reduced to common carbonate. Now, what must follow? Bi-carbonate of lime is a soluble substance, and the solution of it i water is transparent; but common carbonate is not soluble, that is, water cannot retain it in solution; consequently, the newly-formed carbonate falls down as a cloudy precipitate. Every one knows that if a common carbonate of lime, as powdered chalk, or limestone of any kind reduced to the state of a powder, be mixed with water, they will not dissolve; but, after causing at first the fluid to be turbid, will, after some time, settle to the bottom as a powdery or pasty mass, leaving the water quite free. This is exactly what happens in the case we have mentioned, with this difference, that the precipitated carbonate does not fall down in the state of a loose powder or soft pasty substance, but forms a hard crust; and it is this crust which we call *furr*, and which lines the insides of our tea-kettles. All waters that deposite furr in kettles or boilers must have had in solution *bi-carbonate of lime*, which has been thrown down in the state of *common carbonate*, in consequence of the boiling of the water sending off and dissipating part of the carbonic acid.

2826. *From this explanation, the remedy for water having carbonate of lime in it will be easily understood.* Boil the water for some time, and the carbonate will separate and fall down. Some waters clog the kettles and boilers much faster than others, owing to their having a very large portion of carbonate of lime. It is well known that this is a serious inconvenience in steam boilers; and when tea-kettles become much furred they do not boil water so readily.

The remedy just mentioned, of precipitating the carbonate of lime by boiling, is tedious, and can only be effected on a small scale: another method has been suggested, which answers immediately, and on any scale whatever, rendering the water soft as far as that depends upon freeing it from the carbonate. Add to the water some quicklime, formed into the consistence of cream, with water. Diffuse this through the water to be purified: the quicklime attracts the excess of carbonic acid in the water, and becomes common carbonate of lime, which is insoluble, while, at the same time, the bi-carbonate, previously held in solution, being deprived of its excess of carbonic acid, also becomes common insoluble carbonate, and both fall to the bottom, leaving the water pure. It is to be observed, however, that though this process will effectually render the water soft, if the hardness be owing to carbonate of lime, and that such water will no longer curdle soap, and may be used for washing, yet there will be danger of more lime being used than is necessary for the purpose, and the superabundance will remain in solution in the water, which is then, in some degree, lime-water; indeed, it will scarcely be possible to proportion the lime so as to avoid this. Quicklime, which is caustic, has been employed with this view by laundresses, and the consequence has been that, using too much, the linen has been corroded and injured. Nor would it be advisable to employ this method with water used as a constant beverage; but for many purposes the method may be valuable.

But, though these methods will free the water from carbonate of lime, the sulphate of lime, another source of hardness, must be treated by a different process. The sulphuric acid, not being volatile, cannot be driven off by boiling; but the sulphate of lime must be decomposed by adding some alkali for which the acid of the sulphate has a stronger attraction than for the lime. This may be either soda or potash. The sulphuric acid will seize the alkali and let go the lime; at the same time the sulphuric

acid, being now saturated with the added alkali, can no longer act upon that of the soap. This is one of the reasons why soda is found so useful in washing in some of the waters round London, besides its immediate action as a detergent. In these waters there is generally more or less sulphate of lime, which causes a degree of hardness, and this hardness is destroyed by the soda.

This remedy is sufficient if the water be employed only for washing; but, as the addition of soda to sulphate of lime would convert it into sulphate of soda, or Glauber's salt, it would be a matter for consideration with the physician how far a minute portion of this newly-formed salt would be injurious to the constitution in using the water as a beverage. It is very generally stated that hard water is prejudicial if taken long as a beverage. It is apt to cause a sensation of weight, particularly in that weak condition of the stomach which exists in dyspepsia. The water of Paris contains some sulphate of lime, and occasions uncomfortable feelings to strangers who drink of it for the first time.

2827. Sulphate and carbonate of lime being properly insipid substances, they do not impair the taste of the water nor injure its transparency, while the agreeable coolness of water brought up from a considerable depth in the earth renders it frequently very agreeable; but, though a very minute quantity of these salts may not be prejudicial, there is little doubt that waters very hard are unwholesome if used for a length of time. It has been said that they give rise to calculous complaints; but it is not an easy matter to prove this, since, "with the exception of lime, the substances found in hard waters do not enter into the composition of calculi; their operation, therefore, must be rather of a predisposing nature, and is probably exerted upon the organs of digestion, which are well known to be intimately connected with the kidneys."

Late observations, indeed, have given another view of this subject: the formation of calculi appears to be owing to an undue secretion of lithic acid occasioned by indigestion, generally indicated by acidity in the stomach; and it is now said that hard water, containing an impregnation of carbonate of lime, so far from increasing the disease, acts as a remedy by neutralizing the acid in the stomach, and is, in fact, a useful beverage to this class of invalids. In this respect there may be essential difference between an impregnation of sulphate and of carbonate of lime; and it is only the latter which can be advantageous, acting in the same manner as chalk.

Dr. Paris observes that "animals are more sensible of the impurities of water than man. Horses, by an instinctive sagacity, always prefer soft water; and when, by necessity or inattention, they are confined to the use of that which is hard, their coats become rough and ill-conditioned, and they are frequently attacked with the gripes. Pigeons are also known to refuse hard, after they have been accustomed to soft, water. Hard water has also a tendency to produce disease in the spleen of certain animals, especially sheep."

2828. *The proportion of salts varies considerably* in waters that are considered as hard, and we have stated that no natural water is absolutely free from them. But it is not necessary for the ordinary purposes of life that water shall be as pure as when it has been distilled: when water is transparent, colourless, entirely tasteless, and without smell, and will answer for the purpose of washing, it may be considered as pure and good water; but the salts should not be in such quantity as to stimulate the bowels to increased action, nor should the water refuse to unite with soap.

2829. *Brackish spring water* contains common salt, muriate of magnesia, and muriate of lime, all of which exist in sea water; and the springs must owe these either to some communication with the sea, or to the proximity of some bed of rock salt through which the springs pass. *Brine springs* contain so much salt that it is procured from them by boiling and evaporation; several of these occur in Cheshire and Worcestershire.

[Brine springs, or salines, as they have been called, are very numerous in various parts of the United States, especially in the western section of New-York, where, as on the borders of Onondaga Lake, the brine is of such strength that, from some of the wells or springs, thirty to forty gallons will yield a bushel of excellent salt. The manufacture of salt from the springs of Onondaga county employs many thousands of labourers; and, while it is productive to the proprietors, constitutes a fruitful source of revenue to the state, nearly four millions of bushels being annually inspected at these works. As the improvements in the works, though yearly increasing, are not yet perfect, there is still an immense waste of brine, which might be obviated by greater skill in the process, and improved machinery. Experiments are in progress under the patronage of the state, and these objects, it is hoped, will ere long be secured.

Three modes of manufacturing salt are pursued at the Onondaga springs, viz., 1, solar evaporation; 2, evaporation by artificial heat; and, 3, rapid boiling in kettles.]

2830. *What are called petrifying springs* are intimately connected with this subject, and we cannot introduce their explanation in a better place, as it will throw still farther light on what we have been discussing. The vulgar notion of a petrifying water or spring is, that it will convert into stone any substance thrown into it. This is, however, altogether an erroneous idea; there is probably no such water or spring, in this sense of the term. No water in any country, *as far as is known*, has *now* the property of converting wood into stone. Petrified wood is frequently found imbedded in ancient rocks; but the date of such petrifactions is entirely unknown, and is probably of incalculable antiquity. Modern waters said to have a petrifying quality do not convert the substance of wood into stony matter, but only incrust the wood with a deposition of

carbonate of lime, precisely analogous to the furr of a tea-kettle; and the piece of wood so incrusted will be found within this incrustation perfectly unchanged. Several springs of this kind are well known in various parts of England, particularly at Matlock in Derbyshire, where many substances, as birds' nests with eggs, branches and leaves of trees, &c., or, in short, any objects thrown into them, are petrified, as it is improperly called. These springs hold carbonate of lime in solution, in the manner we have stated above; and when the water issues from the ground, and is exposed to the atmosphere, the excess of carbonic acid flies off, without boiling, and the bi-carbonate, thus reduced to the state of common carbonate, is precipitated as a crust over any substances at the bottom. Such objects are, therefore, merely *incrusted with carbonate of lime*, and are properly *incrustations, not petrifactions*, the latter term being applied only to the effect of very ancient and unknown operations, by which every particle of the original body has been removed, and stony matter *substituted* in its place. If a piece of really petrified wood, for example, be broken across, no wood will be perceived in the interior; the whole will be mineral matter. Science is yet unable to explain satisfactorily this effect, as well as many others in the natural history of the earth, and the cause has never been seen in operation.

[Petrifying springs are not infrequent in America, and in Western New-York they are numerous, so that specimens of the most delicate parts of vegetables, replaced by carbonate of lime or silica, without any alteration in their form, are found in great variety. And these are not merely incrustations, as in the formation of stalactites, calcareous tufa, or travertin, but are often true petrifactions, in which the conversion of the wood into stone is proven by analysis, not a trace of vegetable matter being discoverable, the petrifactions consisting wholly of lime in the form of carbonate, with minute portions of silica, alumina, and oxyde of iron.]

2831. *Soft spring water* is nearly the same as rain water; it is, indeed, only the latter which has passed through the earth without meeting with any soluble substances to alter its purity: it is very seldom quite so pure as rain water. Some waters of this kind are so pure as to possess even a medicinal celebrity. The waters of Malvern and of St. Winifred's Well in Flintshire are very pure waters, having no mineral impregnation; and it is thought that their salubrity is owing to the great solvent power which water has when in a very pure state. The sweetness of water is a term that merely expresses its purity.

Although hard water is improper for many domestic purposes, yet there are many cases in which the *hardness is no detriment*, and there are several in which *it is even advantageous*. Soft and pure water has, as we have stated, a much greater solvent power than hard; therefore in culinary operations, where the object is to soften the texture of animal or vegetable matter, or to extract from it and present in a liquid form some of its soluble parts, soft water is the most effective, and to be preferred. In brewing, boiling, or stewing meat, making soup, or any extract whatever, soft water is best.

2832. *But if we consider the cooking of vegetables*, we shall find that in some instances hard water is better than soft; and this the cook knows practically at least, by throwing salt into the water, which makes it hard. Soft water without salt has too powerful a dissolving effect upon green vegetables; it makes too tender, destroying that firmness essential to the preservation of their juices, which are thus dissolved and extracted, and the vegetables consequently rendered insipid, at least to English palates. Together with the juices the green colour is extracted, and the vegetables rendered pale, and even yellowish.

2833. *In boiling fish, likewise*, the contrary to boiling meat, it is not required merely to render the fish soft, but to preserve a certain degree of its firmness. Salt is, therefore, put into the water in boiling fish; hence it is evident that, in this case, hard water is at least as good, if not better, than soft.

2834. *It may therefore be laid down as a rule in domestic economy*, that when the object is to dissolve substances, to render them soft, or to extract the virtues of anything, as in soups, broths, stews, &c., then soft water is the best; but when the object is to cook the food by preserving the juices as much as possible in the substances, hard water is preferable. This, it is to be remarked, although correct, is not the prevailing opinion acquired from books on cookery.

2835. *It should be observed that the terms hard and soft, as applied to water, are only relative*: but water which contains as much as five grains in the pint of saline matter is generally regarded as too hard for washing, and many other economical and manufacturing processes.

2836. *The temperature of springs is uniformly the same all the year round*; hence in summer the water is considerably cooler than any other water: that coming to the surface is more easily affected by the change of season.

2837. *Some springs are, however, naturally warm, and some are hot, and even boiling hot.* When they are warmer than ordinary, they are called *thermal springs*. When a spring is warmer than usual, but still below the temperature of the human body, it is said to be *tepid*; a good example of which is the waters at Buxton, which are always at a tem-

perature of 52°; it is perfectly transparent and colourless, and only differs in its temperature from any ordinary spring. When the spring is warmer than the heat of the body, but not so warm but that the hand may be borne in them, they are called *warm springs*, as those of Bath, which are about 116°, above that point, and to the boiling point, they are *hot springs*. Of the latter there are none in Britain. Thermal waters are generally pure, seldom saline; occasionally, however, they are so, as at Carlsbad in Bohemia, where they have the temperature of 165°. In Iceland, there are several large springs which issue from the ground boiling hot, the most remarkable of which is that called the Geyser.

Sect. V.—WELL WATER.

2038. *The water of wells*, sometimes called *pump water*, when the wells are of great depth, is derived from springs; therefore it is essentially the same as spring water, and, like that, must vary with every locality, being hard or soft, according to the various impregnations it has received.

2039. *We stated, when treating of the choice of the situation* for a house, the importance of having an abundant supply of good water. Frequently, to procure this, a well is to be dug, and upon the success of this experiment sometimes the decision on the situation depends.

2040. *The probability of finding water in any spot* depends upon the geological structure of the surrounding district; and as this varies in different places, no rules followed by well-diggers in one district will apply to another. The experience of the well-digger is generally limited to a certain district, and he too often thinks that the observations which he has made in one spot will apply to all the world, and this is very apt to mislead.

2041. *The study of geology furnishes the only true guide* in the search after the proper spots to sink wells in; therefore the geological examination of the surrounding country should precede every other step to be taken with respect to sinking for water.

2042. Wells are always sunk till they penetrate some loose stratum which is charged with water, and which is placed between two other strata impenetrable by it.

2043. Wells are of two kinds: 1, common shallow wells, which are often only reservoirs; 2, Artesian wells, or constantly flowing wells depending upon a high source.

Shallow wells often penetrate a thin stratum or two, *a*, *a*, *fig.* 822, and enter another of sand or some porous substance, *b*, *b*, in which water is contained. When this stratum is pierced, water appears, and is called a spring. Should this not communicate with any higher source, the water that drains into the well sunk down to *c* will not rise upward, and therefore it is necessary to sink this well deeper, so as to form a reservoir for the water that runs into it from the stratum *b*. In some cases, the well is a mere tank into which the water may ooze from the gravel on the surface. This is the case with most of the *shallow wells* round London. The water of such wells of no great depth are very apt to be contaminated by the various substances in the soil, as iron, lime, and even putrid matters; the first two would give them inconvenient properties, but the latter would render the water highly prejudicial. Many instances have occurred of disease being produced from bad water, and particularly in cases where churchyards have been suffered to contaminate the sources from which wells have been supplied, a circumstance which does not appear to excite so much alarm as it ought to do in the English metropolis.

Fig. 822.

2044. *An Artesian well* is a deep well sunk down as at *f*, *fig.* 822, to some stratum fed by a high source. When the stratum with water is arrived at and pierced, the water suddenly rises in the well as high as the source of the spring, *e*, which may even be higher than the ground where the well is sunk, and then the water will pour out as a fountain, or flow over. The *deep wells* in London are of this kind, and the water in them is remarkably pure. The name Artesian is derived from the province of Artois in France, where, it is said, they were first executed. Wells of this kind are now become extremely common, since the operation of boring is often found sufficient.

Sect. VI.—RIVER WATER.

2045. *River water is composed partly of spring water and partly of rain water.* The principal source of the water of rivers is mist and rain. The former, consisting of the masses of vapour called clouds, are condensed upon mountains, whence a thousand rills of transparent soft water, which unite together into streams and rivulets, either flow into lakes, or, by their union, compose great rivers. Since rivers wind through various regions of the earth, their waters will necessarily vary considerably in the substances which they contain, the nature of which will depend upon the season of the year, and whether they have been increased by snow and floods, or whether, from the heat of the summer, they are more or less impregnated with animal and vegetable matter. Another source of the supply of rivers, but one much less considerable, is derived from springs, which, consisting of water that has long filtered through different strata, is sometimes

extremely pure, and in other places highly charged with mineral salts. The proportion of these last, however, being comparatively small, river water is in general remarkably soft, and next in purity to rain water.

2846. *After storms rivers become muddy* from the earthy and boggy matter through which they pass, and which they sweep away as they swell above their ordinary channel. It is evident, also, from what has been said, that the water of rivers must be purer the more we advance towards their sources; and that the greatest quantity of contaminating matter will be found where they nearly reach the sea, the water in their mouths being brackish.

2847. *Some streams that flow over a rocky or pebbly bed*, particularly those in a mountainous country, as in Wales and Switzerland, are remarkably pure and transparent, having been filtered by the clean siliceous pebbles and sand through which they pass; rivers that wind through plains composed of soft strata are often extremely muddy, though they may be free from saline contents.

2848. It is here important to notice and explain the difference between impurities being *mechanically suspended* in water and *being dissolved* in that fluid. If fine sand or clay be agitated in a glass of clean water, a turbid mixture will be produced; but if the water be suffered to rest quietly for a day or two, all the sand and clay will settle to the bottom, and the water will remain perfectly clear as at first. The particles of the sand and clay were merely suspended for a time in the water, in consequence of the motion given to it, their extreme minuteness rendering them easily disturbed; but when that motion has ceased, these particles being specifically heavier than water, that is, fragments of substances that would sink in water, they fall to the bottom, or subside by their superior gravity: rest, therefore, for a certain time, is alone sufficient to separate such substances. But the case is very different with what is actually dissolved in water. Take, as an example, some common salt. This, in dissolving, disappears entirely: it does not cause the water to be muddy, and if the fluid stand quiet ever so long, not a particle will fall to the bottom. The salt is here chemically united to the water, and no rest can have any effect upon it so as to separate it. This is the case with all the salts which are held in water; and, likewise, with some other substances, as mucilage and gelatin, or gum and glue, which will dissolve in the same manner, and will not fall down in consequence of rest.

2849. *Though the water of rivers is produced from the union of that of springs with rain water*, and hence must contain the salts of the former, together with a variety of matters collected by the rivulets and streams which flow over the surface of the earth, yet in general, as we said before, it possesses considerable purity. Much of the carbonate of lime is deposited during its passage through the water, being exposed to the air; and the greater part of the animal and vegetable substances carried down into it is held merely in a state of mechanical suspension, and is not dissolved; for while the water is in constant motion, the putrefaction of these matters does not take place, or in a small degree; hence the greater part may be separated by subsidence when the water is suffered to be at rest, or by filtration.

2850. *But it should be remarked that though river water, even when originally extremely foul, may be purified* by means of filtration to a very considerable degree, yet it can scarcely be expected that it can thus be deprived entirely of all impurities, since, notwithstanding all possible care, some small portion will escape the best filters. If the filters, however, are good, the quantity of these will be extremely small; but the impurities which have been dissolved in the water cannot be separated by ordinary filtration. See, farther, Sect. X., "Filtration."

2851. *River water is almost always soft*, because the principal portion of it has been collected from rain water that has never passed through the strata, but flowed only upon the surface, and because the greater part of the earthy salts have had time to be deposited; but from the most noxious impregnations consisting of animal and vegetable matters which have been carried into it, or which have been generated in the rivers themselves, by various aquatic insects and plants, and which have been partly mechanically suspended, and partly dissolved in the water, it is never quite pure. If such river water be suffered to rest, part of this matter will subside, but some will still remain; and though putrefaction did not take place while the water was in motion, yet this effect will happen whenever the water becomes stagnant.

2852. *For this reason it is very desirable that artificial pieces of water* employed to ornament pleasure grounds should, if possible, have some motion, to prevent the bad effects always produced by stagnant water.

What has been said of artificial lakes and ponds applies, likewise, to reservoirs of every kind.

2853. *Rivers which issue from lakes* are generally very pure and transparent, because all the sediment has been deposited in the still water, and the stream that issues is free from the mechanically suspended impurities that were brought into the lake. The Rhone coming out of the Lake of Geneva furnishes a good example of this fact.

2854. *In countries where bogs and peaty marshes abound*, the rivers are often tinged with

a brownish colour extracted from the peat, and which does not easily separate from the water.

2855. *The taste of river water* is more vapid, and less agreeable, than that of spring water, because the former has lost all its carbonic acid in consequence of long exposure to the atmosphere; and it is this which renders spring water so pleasant as a beverage.

2856. *Many capital cities are supplied with river water*, as London with the water of the Thames, Paris with that of the Seine.

The Thames water is of itself remarkable for its softness and purity, although in passing through London it receives a great deal of impurities from sewers, and various other local causes. Most of the foulness with which it is in this way contaminated is only suspended, and not dissolved, in the water, and, therefore, mere rest causes much of it to subside, and the greater part of the remainder of what is merely suspended might be separated by filtration: the same may be said of the New River water.

The water of the Seine has been carefully examined by Parmentier, and appears to be of great purity, notwithstanding the numerous manufactories, as dyers, tanners, hatters, &c., which crowd on its banks, but it contains more lime than Thames water.

Sect. VII.—Ice and Snow Water.

2857. *The water from melted ice is nearly pure*, as almost all saline substances are separated by the freezing of the water; even the ice of salt water is nearly fresh, and is used in some places for brewing: but the air contained in the water is likewise separated by this process. Ice water is therefore similar to what has been boiled, in consequence of which fish will not live in it except it be afterward exposed to the air for some time. It has a vapid taste, and does not appear to quench the thirst, nor to act as a solvent in the digestive process so well as rain water. Water from melted snow agrees in its properties with that from ice.

2858. It has been supposed that ice and snow water are unwholesome, and that they give rise to the unseemly disease, the bronchocele, or *goître*, which disfigures so many persons in the Alpine valleys who are obliged to drink snow water for a great part of the year; but this opinion is no longer admitted by physicians, who observe that the "same affection prevails in Sumatra, where ice and snow are never seen; and, on the contrary, that this complaint is unknown in Chili and Thibet, although the rivers of these countries are derived from the melting of the snow with which the mountains are covered." Captain Cook, and other navigators, have proved the wholesomeness of ice and snow water, which they have been obliged to depend upon entirely in high latitudes; and in the polar regions, thawed snow and ice forms the constant drink of the inhabitants during winter, and of the mariners who visit them.

This kind of water is perfectly soft, dissolves soap readily, and will keep good for many years.

Sect. VIII.—Sea Water.

2859. *The saltness of the sea is, no doubt, one of the wise arrangements of Providence* to prevent the evils which we perceive in stagnant fresh water. The saline impregnation prevents the putrefaction of the animal and vegetable remains with which it abounds.

2860. *According to Dr. Murray's analysis*, a pint of sea water on our coast contains, lime, 2·9 grains; magnesia, 14·8; soda, 96·3; sulphuric acid, 14·4; muriatic acid, 97·7; total, 226·0; or, if we consider these substances as combined in the water, it will be, muriate of soda, or common salt, 159·3 grains; muriate of magnesia, 35·5; muriate of lime, 5·7; sulphate of soda, 25·6; total, 226·0, or 1 of saline contents to about 30 of water. It is the muriates of magnesia and lime that give the bitterness which we taste in water of the sea. This water will not do for washing, on account of the salts which it contains; nor, for the same reason, is it proper for preparing food.

2861. *The steam which rises on the boiling of salt water is* nearly quite fresh, scarcely any of the salt rising with it; hence it might appear that we have an easy method of obtaining fresh water from the sea, since, for this purpose, it is only necessary to subject salt water to the common process of distillation, and the water formed by the condensation of the steam in the usual way will be fresh, the salt remaining behind in the still, or any vessel employed for distilling. Yet simple and obvious as is this process, it does not appear to have occurred to the early navigators, who were often distressed for want of fresh water, when they might have supplied themselves by this method. The ancient Greeks, indeed, who were acquainted with the art of distillation, are said to have procured fresh water at sea by suspending large sponges in the mouths of brazen vessels in which salt water was boiled; when the sponges were saturated, they squeezed out the fresh water. This certainly may be regarded as the infant state of distillation; but the quantity of water procured in this manner must have been very small. The discovery of the process of distilling by the moderns put mankind in possession of a new power.

The first account we have of the obtaining fresh water at sea by distillation is in the reign of Queen Elizabeth, when it was put in practice by Sir R. Hawkins. Experiments were afterward made by Hales, Lister, and various philosophers, and the practicability of the method established. M. de Bougainville, in his voyage

round the world, derived great assistance from it; and Dr. Irving received, in 1770, a parliamentary reward of £5000 for introducing it into the British navy. Lord Mulgrave tried it with success in 1773, in his voyage to the North Pole, since which time it has been perfectly understood.

The method practised by Dr. Irving was this: the ship's kettle was divided into two parts by a vertical partition; in one of these divisions was the soup or meat to be cooked, and in the other, sea water to be distilled. The same fire boiled both, and therefore, at the same time that provisions were dressing, fresh water was distilling. Three fourths only of the sea water was distilled off, since, when the brine became strong, the distilled water had a disagreeable taste from a partial decomposition of the brine. The farther distillation was also found to injure the boilers.

This construction has, since that time, been varied in many ways, but the general principle must always be the same. All that is necessary is some method of condensing the steam which is raised by the boiling of salt water, in the manner of a still; and the particular form and construction of the apparatus may be varied to suit the place where it is used. On board ship, advantage is generally taken of the kettles for cooking, and the steam from these is condensed with little expense and trouble. In long voyages, and even where there has been no particular scarcity of water, it has been thought prudent to employ apparatus of various constructions for this purpose, to lessen the quantity of water taken in, and to provide against accidents.

2862. *But it is to be observed that, although distilled sea water is all but fresh,* and will answer for washing or cooking, yet it is not completely so. It contains a little muriatic acid, and is not very fit for drinking. A little chalk or alkali added neutralizes the acid; still, it is not found so good as to supersede the necessity of having fresh water from the land.

SECT. IX.—STAGNANT WATER.

2863. By the term *stagnant* we should understand water simply *in a state of perfect rest,* or altogether without any current, whether it be a lake or a small pond, and whether the water be clean and pure, or very foul. We mention this the more particularly, because many persons mistake the meaning of the term, and suppose that the word stagnant applies only to water that has already been rendered foul by remaining in that condition. Strictly speaking, it is the *state of rest,* and not its quality, that constitutes the stagnation of water.

2864. *But stagnant water exposed to the air, if ever so pure at first, will not long remain so;* for it soon becomes inhabited by myriads of animalculæ, and aquatic insects of a great number of species, many of which pass some of the stages of their lives beneath its surface, and their exuviæ, or remains, become putrefied, and contaminate the fluid. The vegetable kingdom also here extends its influence. There are a great number of plants, many of which, called *conferva,* are so minute as to be scarcely observable by the unassisted eye, which propagate in still water, and often serve as food to the insect tribes.

Thus stagnant water, like every portion of the superficial part of the earth, teems with life; and the accumulation of the dead remains of animals and vegetables communicate to it properties highly deleterious. We stated that water perfectly pure is incapable of change by itself, whether in rest or motion; but no water, however pure at first, if kept perfectly stagnant and exposed to the atmosphere, can continue long in a wholesome state, or fit to be employed in preparing food, from the causes just stated. Boiling and filtration may, indeed, correct much of these bad qualities; still, it can never be so safely used as running water. These observations apply to reservoirs of all kinds when employed in arrangements for supplying water, if freely exposed to the air and light.

2865. *Stagnant water has often a greenish colour,* which is derived from an infinity of minute plants that can only be seen by the microscope: much of this will be retained by the filter, but some will also pass through, as well as part of the mucilaginous juices of plants and animal fluids, and thus the results of putrefaction will probably remain, notwithstanding every care bestowed in filtering; but to what extent it is not easy to say. The transparency alone of filtered water, therefore, will not form a complete test of its purity. See "Filtration," Sect. X.

2866. *The water of lakes and ponds is, properly, stagnant;* but these may vary exceedingly, according to circumstances. Lakes are generally supplied from streams and brooks, which flow into them, some of which have been produced by rain, and others have risen from springs. Here much will depend upon the size of these pieces of water, and the nature of the bottom. The water of deep lakes is agitated by the wind, and is not so liable to have vegetables growing in it. The water of large lakes is generally very pure; but some contain so much salt as to be called salt lakes. It is in shallow water that the numerous confervæ, and other minute species of plants, grow, and which render the water so deleterious; and hence the brownish-green, slimy substances so often seen in shallow ponds.

2867. *The water of marshes is the worst of all.* Marshes are places where the stagnant water is very shallow, and where the greatest quantity of plants of various kinds, and likewise numerous tribes of insects are produced, and, consequently, where their dead remains are the most abundant. The putrefaction of these substances gives rise to poisonous effluvia, which contaminate the air, and often occasion fatal diseases. Such water should be carefully avoided; nor should it be employed in any way whatever for human sustenance if other water can be obtained.

2868. *But the water of a peat bog,* though stagnant, is of a very different quality from

that of a marsh. This, indeed, from some property in the peat itself, instead of containing putrid matter, is remarkable for resisting putrefaction; and therefore the same unhealthy gases are not disengaged from the water of a peat bog as from common marshes. This fact is of great importance, and it is observed that the vast peat bogs in Holland, Ireland, North of England, and parts of Scotland, are not at all unhealthy, but the contrary; and the same may be said of those stagnant ponds of water occasioned by the rain filling those cavities from whence peat has been cut. If the swampy surface of bog land in general, and the water contained in these ponds, were equally liable to putrefaction as marshes, the districts containing them would be uninhabitable.

Sect. X.—MINERAL WATERS.

2869. *There are several other salts which occasionally occur in water;* but they are much less frequent than the sulphate and carbonate of lime which we have mentioned. When others occur, they are sometimes in too minute quantity to be perceived by the taste, and can only be discovered by chemical tests. Occasionally, however, they exist in much greater proportion, so as to be discoverable by the palate, and then the water is said to be *mineral*, and is altogether unfit for most domestic purposes. Sulphate of lime and carbonate of lime are generally found together; we rarely have one without the other. *Chlorides of calcium* and of *magnesia* give great bitterness to waters when they occur in them. They are found in the waters of the Dead Sea in Palestine, and in many mineral springs. *Sulphate of magnesia*, or *Epsom salts*, so called because first noticed in the springs at Epsom, where they still exist, is not unfrequent. *Sulphate of alumina* is found sometimes, though rarely.

2870. *When salts of iron are found in water*, it forms what is called a *chalybeate*, and is known by its austere, astringent taste. But the iron sometimes exists in smaller quantity than is sufficient to warrant the appellation of a mineral water. Iron is usually found in water in one or other of two states: either joined to sulphuric acid, constituting sulphate of iron, or what is vulgarly called copperas; or as a bi-carbonate of iron, that is, iron joined to carbonic acid. When the iron is in the state of bi-carbonate, it deposites an ochrey sediment on being exposed to the air for some time, and still more on being boiled; but when it is a sulphate there is no sediment.

2871. *Iron, in whatever mode it exists in water, may be discovered* by its striking a black, or deep violet colour, with tincture of galls, or any substance containing the gallic acid, or tannin (tannic acid); consequently, it would be totally unfit for making tea, as it would convert it into a kind of ink; and it stains black all wearing apparel which have been dyed with tan. Iron is far from being deleterious in small quantity in water, but in a considerable proportion becomes medicinal. The mineral springs at Tunbridge Wells contain bi-carbonate of iron, and that of Sandrock, Isle of Wight, sulphate of iron.

2872. *Chalybeate waters are extremely common:* the most noted in Britain are those of Tunbridge and Cheltenham; but there are several round London, particularly at Hampstead, which were much resorted to formerly.

2873. *Besides the earthy, alkaline, and metallic salts* we have mentioned, mineral springs have considerable quantities of *several gases*. Sometimes there is free carbonic acid gas, and then the water has an acidulous taste. Sulphuretted hydrogen gives it a smell and taste resembling that of rotten eggs, as is the case with the Harrowgate water.

2874. *Accordingly, mineral waters are divided, from their contents*, into acidulous, saline, alkaline, chalybeate, and sulphurous. It would be foreign to our object to go farther into the subject of mineral waters, as they do not come into the list of beverages.

[The mineral springs of the United States are numerous, and found in almost every part of our country, many of which are more valuable as medicinal agents than any in the Old World, as shown by analysis, and, what is still more conclusive, by their curative effects and direct physical action upon the human organism.

The most noted are those of Saratoga and Ballston, in the State of New-York, where, for many miles of surface, there would seem to be a succession of medicated waters gushing forth from the bowels of the earth, inexhaustible in their sources, and each possessing a distinctive, though more or less analogous character in chemical composition and in medicinal effects; and yet some of these springs are found in close proximity to each other, often within a few feet, and yet essentially different both in their nature and effects.

They may all, or nearly all, be said to be chalybeates; but the proportions of the salts of iron they contain vary very remarkably, in some of them being from 5 to 10 grains of the carbonate of iron to a gallon, while others contain less than one fifth of that proportion. The same differences are observed in the relative proportions of other salts, and some of them contain ingredients no trace of which can be discovered in others. Their adaptation to various diseases, and to varied morbid states of the system, requires accurate discrimination, for lack of which there can be little doubt that positive injury has resulted from the indiscriminate, and especially from the excessive use of these waters.

The spring which has the highest reputation at Saratoga is the Congress Spring, and

its water is highly carbonated, besides containing a large proportion of chloride of sodium, bi-carbonate of magnesia, and carbonate of lime, with a smaller quantity of the hydriodate and bi-carbonate of soda, carbonate of iron, and a trace of silex and hydrobromate of potash. Its use is found to be decidedly aperient and tonic when freely employed, and in smaller quantities it possesses alterative powers, adapting it to chronic maladies. Congress waters are bottled and sent all over the country, and a regular supply is kept in most of our large cities, so that, as an article of commerce, it is to the proprietor of the spring a source of great emolument. Thousands annually resort thither from every section of the United States during the summer months, either in pursuit of health or pleasure, ample accommodations being provided in the numerous hotels and boarding-houses of the village.

There are also in Virginia a number of valuable mineral springs, little less celebrated for their medicinal virtues, both for drinking and bathing. There are cold, warm, and hot springs, abounding in sulphur, and their curative powers in cutaneous eruptions, and some other chronic diseases, render the several localities of these springs very fashionable resorts. The limits within which these notes are restricted, however, forbid any other detail, although there are various other springs, north and south, which are in great repute among invalids.]

Sect. XI.—PURIFYING WATER.

2875. *As it is sometimes impossible to procure water pure* and fit for domestic purposes, it is important to know by what methods it may be *purified*, as it is called, that is, deprived of those substances which contaminate it; for it is to be remembered that water, in itself, is necessarily pure and incapable of change, and that when it is unfit for use the cause must be attributed to the presence of foreign matters; in other words, substances which do not belong to it.

2876. Before anything can be determined on this subject, it is necessary that we should have a clear idea of the substances with which water is usually contaminated, and of the mode in which they exist in it. We have already explained, when treating of river water, the difference between materials being in mechanical suspension and dissolved in water.

2877. *The bodies which are merely suspended in the water*, and not dissolved, are earthy powders, as clay, lime, and a mixture of various mineral matters of all kinds, which have been washed down from higher grounds, and are completely mixed up in the water, giving it a turbid appearance. Parts of animal and vegetable bodies are likewise found in water in a state of mechanical suspension, as portions of insects, of fish, dead leaves, fragments of wood and branches, grass, and every part of the animal and vegetable kingdoms. We may have a good idea of what may thus be contained in water, by observing what is brought by rivers in freshes, when the water is quite muddy. Extremely fine sand may be in this list of substances; but when the particles are large they subside immediately, and cannot be said to make water turbid.

All the particles that are specifically heavier than water will subside to the bottom; but if any substances should happen to be of the same specific gravity as water, they will not subside, but will remain suspended anywhere in it; and those particles which are only a very little heavier than water will not fall down until after a considerable time. Everything, in short, may be suspended in water that is light enough not to sink to the bottom immediately, and which cannot overcome the agitation of the fluid. But in general all such matters do subside after the water has stood a sufficient time.

It is very remarkable, and a proof how beautiful is the economy of nature, that there are very few substances in the world that are exactly of the same specific gravity as water: were there many such matters, this fluid would scarcely ever be clear.

2878. *Purifying water by subsidence* is performed by collecting it into a reservoir, and suffering it to remain perfectly at rest; when, in the course of time, those substances which are only mechanically suspended will sink to the bottom. But this method alone is very imperfect, and can never effect the complete purification of water, since, as we have stated, there are a number of extremely minute particles so nearly of the same specific gravity with water, that they are not able to overcome the tenacity of the fluid, and therefore remain in a state of suspension, and cause a cloudy appearance. These may be separated by filtration, which we shall next describe. Water may also contain salts of various kinds, which cannot be separated either by subsidence or filtration; for these distillation is necessary, by which the pure water rises in the form of steam, and is condensed again, the salts remaining in the still. The filtration of water being an important subject, we must treat of it at some length.

2879. *Filtration is the most general method of purifying water* for domestic economy. This consists in allowing the water to percolate through a porous material, the pores of which are too minute to allow of the passage of any substance mixed in the water. Straining liquids through a sieve, cloth, or sponge is a coarse kind of filtering; and a great variety of materials are employed to perform this operation, suited to the nature of the liquids and other circumstances. The chemist employs unsized or bibulous paper

for his delicate processes, and porous stones have been employed for filtering water for ordinary purposes. Flannel and cloth of various kinds are also used.

2880. *Sponge may be employed for filtering* by compressing it into the neck of some vessel made to hold the water; this substance is very convenient, as it may be easily taken out, cleaned, and replaced.

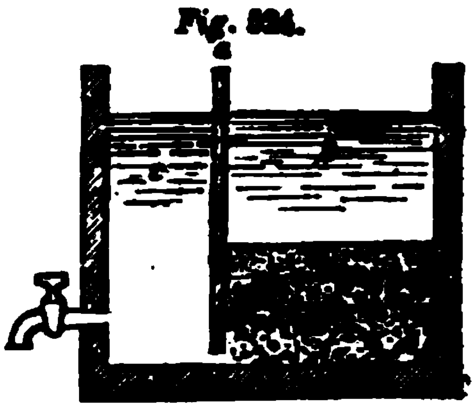
2881. *But the best material for filtering water is charcoal.* This substance not only acts mechanically by its porosity as a strainer, but it has the valuable and peculiar quality of preventing putrefaction by absorbing at once the gaseous matter that is generated, and thus impeding decomposition. Sailors have long been acquainted with this property of charcoal, and they have found it to be an excellent practice to char the inside of the casks in which they take water to sea in long voyages. It was once supposed that the chief use of this was to prevent the water from contracting a disagreeable taste from the wood; but it is now known that it not only effects this, but that it acts much more powerfully by absorbing all putrid matter and offensive odour, and thus rendering, in a considerable degree, even foul and unwholesome water salubrious and transparent.

The best charcoal for this purpose is that produced by burning animal substances, called *animal charcoal*, which is more effective than vegetable charcoal. Charcoal has likewise the property of absorbing colouring matter; brandy may be rendered white by being passed through it, and port wine has been rendered pale; it is also used for whitening the sirup of sugar.

2882. *Nature effects filtration by means of beds of sand.* Water that has percolated through these issues perfectly transparent and clear, and freed from everything except what it holds in solution. Art, imitating nature, employs sand for the same purpose, and filtering beds upon a great scale have been formed for purifying water, the supply of towns, and for domestic purposes. Little more, indeed, seems necessary for rendering water perfectly pure, where the impurities are merely of a mechanical nature.

2883. *To filter water by means of sand*, it is the practice in many places, particularly in France, to construct cisterns in the cellars, and to divide them into two unequal parts by a partition, *a*, *fig*. 524, that does not reach quite to the bottom. The largest of these divisions, *b*, is half filled with layers of sand of different degrees of coarseness, and into this the water to be filtered is put: in passing down through the sand, all the mechanical impurities are detained, and it rises into the other division, *c*, perfectly clear. This method is so simple that it may be practised anywhere without difficulty. The shape and size of the cistern are quite immaterial. If a cock is placed in the smaller division to draw off the water, it should be fixed a little way above the bottom, lest there might be some slight sediment which would be disturbed. It is obvious that the sand can only answer the purpose for a certain time; for it must become clogged with the impurities and sediment from the foul water, and will require renewal more or less often, in proportion to the foulness of the water. The sand should be well washed before it is used, and it should contain no earthy matter, as this would defeat the object of filtration. Clean, sharp sand is best, and it should be separated by sieves into various degrees of coarseness to place in different layers, the finest being put at the bottom.

Fig. 524.



2884. *It may be remarked that when water is filtered by nature through beds of sand*, it *ascends* to the surface, by which the purification is more completely effected than by *descent*. In the latter case, some impurities might be forced through by the weight of the water, or by their own gravity; but, in the former case, gravity must oppose the ascent of the impurities, which are therefore more likely to remain behind. Filters have been executed on this principle, by making the water pass upward through the sand and charcoal, or other filtering materials.

2885. *A very simple apparatus of this kind was made long ago, by M. Parrot, of Paris*, which has been the origin of much of the recent apparatus for this purpose. As it may be very easily executed, it might be sometimes useful to travellers, who may find it difficult, in some situations, to procure pure water. *a b c*, *fig*. 525, represents a curved tube, either round or square, into which sand, or sand and charcoal, are put, up to the level of the dotted line at *c*. A little flannel bag is put into the end *a*, and water poured into this has its coarsest impurities retained by the flannel; and in passing through the sand, in the lower part of the tube, and rising upward to *b*, is completely purified, and drops into a vessel placed below. If found necessary, a piece of linen or muslin may be tied over the mouth, *b*, to prevent any particle of sand coming over. A tube of this kind, about three inches in diameter, will filter about three quarts of water in an hour. The longer the leg *a*, the more rapidly it will filter, from the pressure of the water. The sand should be made pretty compact, for the slower the passage of the water, the more it will be purified.

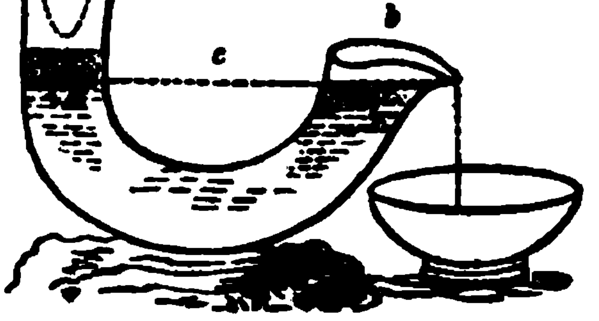


Fig. 525.

2886. *Upon this principle, an improved mode of filtering has been effected* in cisterns, name-

ly, by forcing the water to ascend through the filter, instead of descending. Here the cistern has two partitions, *a* and *b*, *fig.* 526. That at *a* does not reach quite to the bottom, and the other has an aperture at *b*. In the middle division a piece of perforated metal, wood, or stone, or a cloth, is fixed a little above the bottom; on this is placed a layer of small pebbles, then coarse sand and layers of charcoal, then finer sand and charcoal, the whole being covered by another cloth, also fixed just below the aperture *b*. The water to be filtered is put into the division *a*; it then passes below the first partition, and by its pressure rises through the perforated plate *c*, and likewise through the pebbles, sand, and charcoal, and passing through the cloth above it, runs through an aperture in the partition *b* into the last division, from which it is drawn by a cock as it is wanted.

Fig. 526.

2667. *An easy method of cleaning the filtering materials* is by making the water pass through them in a contrary direction to what it does when filtering. For example, supposing, as we have just stated, the division *a* is that which receives the foul water, and *b* that which receives the purified water. Then, to clean the filtering apparatus, reverse the process, and fill the division *b* with unpurified water; it will pass through the aperture in the partition *b*, and descend through the cloth, the sand, and perforated plate *c*, rising in the division *a*, and carrying with it all the impurities, which may be drawn off by a pipe fixed in the bottom.

Fig. 527.

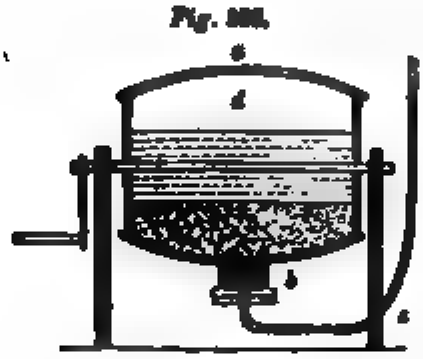
2668. *The principle of filtration being well understood, it may be varied in an infinity of ways*, according to particular localities, or to answer various purposes.

A common cask, *fig* 527, may be divided by partitions, and the filtering materials placed in one of the divisions; or, without any vertical partitions, the cask, as in the annexed cut, may be fitted up for filtering. Let two cross partitions, parallel to the heads, be introduced at *a* and *b*, formed of wood, perforated by a number of holes burned by a hot iron; over each partition put a piece of woollen cloth, and place between them layers of coarse and fine sand and of charcoal. Suppose that *c* is a pipe coming from the roof; the water supplied by it will pass through the filtering materials into the space below *b*, and may be drawn off pure by a cock, or a spigot and faucet at bottom. But suppose that it is desired that the filtration should be performed by ascent, as the most perfect method, then another cistern must be provided and placed on a higher level, as *d*, into which the water to be filtered must be first conducted; the water will descend through the pipe *e*, and enter the lower part of the cask *b*, from whence, by the pressure of the water in *d*, it will force up through the filtering materials into the space above, at *a*, from whence it may be drawn off by a cock. In this case the vertical partition is supposed to be omitted. In either case there should be a waste-pipe in the cask, *h*, to prevent its overflowing, and another in the cistern, *g*.

The foul water may be let off occasionally by the spigot and faucet at bottom. In case of a deficiency of water from the roof, or supposing that none could be had from that source, but plenty from some other source, it is easy to see how the cask might serve as a filtering apparatus. If a funnel, *f*, be put into the top, the water poured into it will pass through the sand in the middle, and come out at the lower cock purified. The best way to clean the sand when it requires it is to take it quite out, wash it and the cask, and replace the sand again.

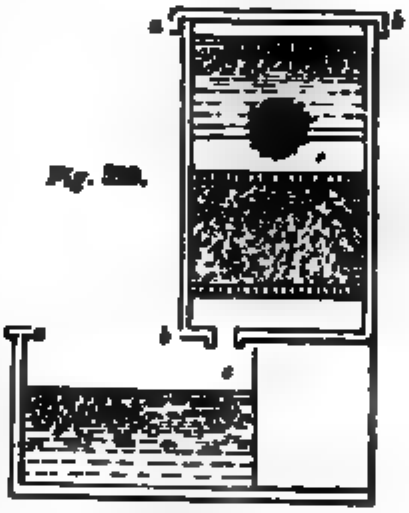
2669. *Another method of employing a cask as a filtering machine* is the following: hang the cask, *a*, *fig.* 528, on an axis passed through it, so that it may be turned round by a winch in the manner of a barrel churn: on the lower part fix a short, hollow, cylindrical piece, *b*, to contain a piece of sponge; and connect with it, by means of a flange and screws, a pipe, *c*, to supply water from a cistern placed at some height above. Put sand and charcoal into the cask about one third full. The water will rise through the sponge and sand, and when it arrives at *d* in the cask, it may pass off by a pipe inserted in the end or side of the cask, as may be found most convenient, into any reservoir or vessel to contain it. When it is required to clean the sand, it is only necessary to take off the pipe, *c*, and the sponge, and having stopped up, temporarily, the short, cylindrical hole where it was placed, give the cask, with water in it, several turns round by the winch; this will wash the sand, and make it ready to filter again.

Fig. 528.



2890. *It must be obvious from the above that a very perfect filtering apparatus may easily be made by any one possessed of the least ingenuity.* All that is wanted is a vessel rather tall than flat, but of any convenient form, as *a b*, *fig.* 529, in which there should be three partitions: the uppermost should have an aperture to contain a sponge stuffed into it, *c*, to stop the worst part of the impurities of the water put in at the top; the two lower partitions may be of wood perforated with small holes by a red hot iron, and having pieces of woollen cloth laid upon them between these two the sand and charcoal should be put, coarsely powdered; and, lastly, there must be a hole in the bottom vessel, at *c*, through which the filtered water may run into anything placed to receive it, and to avoid the expense of a cock, if the arrangement be as in the wood-cut, where the filtering vessel covers only a small part of the lower one, the filtered water may be got out of it by dipping; and a cover over this part will keep it clean.

Fig. 529.



2891. *It may likewise be seen that any conveniently shaped vessel may serve for a filter*, where sand and charcoal are used: any jar, with a hole in the bottom, or even a large garden pot, may serve as a temporary filter. Put a short bit of tube, or a round bit of wood, with a hole through it, in the aperture in the bottom of the pot, *fig.* 530, so as to project an inch below; then put some sand and charcoal into the pot, and on this pour the water to be filtered. The filtered water may be received in a dish placed beneath. The pot is placed on a stool with a hole.

2892. *Water may be filtered to a certain extent, even by so simple a contrivance as hanging a thick wick of cotton or worsted thread over the edge of a deep basin or jar, fig.* 531. The water rises by the capillary at-

Fig. 530.

traction of the threads, and continues to run over into a vessel placed below, leaving the impurities behind.

2893. *An excellent filtering apparatus of stone-ware was made and generally sold by John Hawkins, formerly of Titchfield-street, London*, from which most of those now seen in the shops are copied with slight variations. *a*, *fig.* 532, is the vessel into which the foul water is put: it comes through the cock *b*, and drops into the projecting lip of another vessel, *c*, which has a moveable partition pierced with numerous small holes; on this partition is placed a piece of woollen cloth, or a slice of sponge, to stop the greatest quantity of the impurities in the water; after that it passes through the holes into the lower part, which contains charcoal bruised small. This vessel has in the bottom several small holes which permit the water to pass into a third vessel, *d*, from which the filtered water is drawn by a cock. These filters answered the purpose completely, and have the advantage that all the parts could be easily got at, and therefore they were easily kept in order.

Fig. 532.

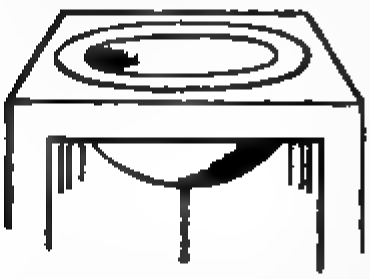
2894. *A large filter, also by Mr. Hawkins*, was made in the following manner: *B*, *fig.* 533, is a cask charred withinside, and having a partition in the middle, *a*, which does not reach quite to the bottom. In the lower part of the cask is put sand and charcoal, or a stratum of charcoal alone, about four inches deep, the upper part of the charcoal in pieces about the size of walnuts, the rest coarsely powdered: this is covered with perforated covers to permit the water to pass through, but to keep the charcoal from mixing with it. The water to be filtered is poured into the division *a*; it then passes downward through the charcoal in the lower part, and rises through the perforated cover in the other division, from which it is drawn off by a cock. The division with the filtered water has an inside cover, *b*, besides the cover over the whole, to prevent any one by mistake pouring foul water into the wrong division.

Fig. 534.

2895. *A*, *fig.* 534, *represents a filtering apparatus made of stone-ware*, which is at present very generally sold in the shops in London: it contains two partitions, which are fixed in with cement. The upper one contains a cavity in the centre pierced with holes; and the

lower one is also pierced in a similar manner. Before they are cemented, sand and charcoal are put between the partitions, through which the water put in at the top filters into the lower division, *b*, after first passing through the sponge to detain the coarsest part of the impurities. The filtered water is drawn off by a cock. An inconvenience attends this arrangement, that the charcoal and sand cannot be easily got at to be renewed, on account of the cement; the partitions should be got out when required by the possessor. These filters, though good, have no peculiar superiority over others where the filtering materials are not so concealed.

Fig. 535.



2896. *Water is also filtered by making it pass through a particular kind of porous stones, fig.* 535, *called filtering stones*, which are hollowed out for the purpose in the form of a basin. The fluid percolates through the minute pores of the stones, which are too small to suffer the impurities to pass, and it appears on the outside in clear drops, which are received into a proper vessel. These filtering stones effect the intended purpose, but the filtration proceeds very slowly, drop by drop, and the stones soon clog up, and are then difficult to clean; they should be frequently scrubbed with a hard brush before the mud accumulates too much in them. On first using, water should be passed through for some time before it is drank, as it is necessary to carry off all soluble matter that may happen to be in the stone, and which gives a disagreeable taste to the water. Stones fit for this purpose are found in many parts of the kingdom, particularly in Derbyshire and Durham; but it is said that the best filtering stone comes from the island of Fuenteventura, and the next best from Barbadoes. Both may be procured through Mr. Joseph Bishop, 1 Crescent, Minories, London.

2897. *An improved stone filter* is made in the following manner: *a*, *fig.* 536, is a hollow vessel made by hollowing out a filtering stone, with a stone cover cemented on; this is placed in a cistern, *b c*, which may be of stone, slate, or wood. The water to be filtered is put into this cistern, and it passes through the sides of the vessel of porous stone, through the vessel *a*, into the inside, towards which end the pressure of the water arising from its depth assists materially; and this apparatus will therefore filter water more rapidly than the last construction. The filtered water is drawn off by a pipe and cock, *d*, and a small pipe open at both ends, *e*, goes through the cistern and upper part of the filtering stone, for letting out the air as the water comes in, and admitting it as the water is drawn off.

Fig. 536.

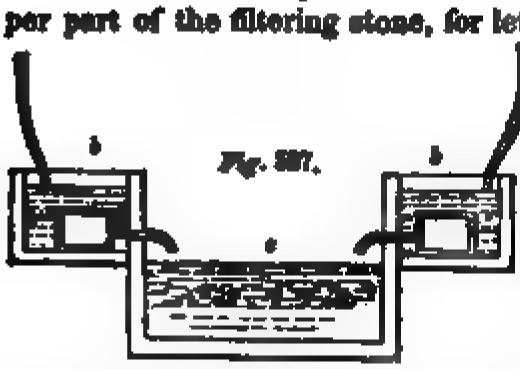


Fig. 537.

2898. *Fig* 537 represents *an apparatus on a large scale* given in the Gardener's Magazine, vol. iv. Rain water is conducted from the roofs by pipes into the small tanks *b b*, in each of which there is a hollow box of filtering stone, into which the filtered water presses. From these stone boxes the pure water passes by pipes into the great tank, *c*, in the courtyard; this tank is arched over, and from it the water is drawn by a pump.

2899. *Filtering on a large scale* may be easily accomplished by means of several filters which may deliver their filtered water into one reservoir; it is in this manner that the water of the Seine is filtered for the consumption of Paris. The filters made use of there are constructed of vessels containing sand of various degrees of coarseness, and charcoal. A vast number are employed, and pipes or troughs from each of them unite together, and at last empty them into the general reservoir. One great advantage attending this construction is, that every part of the apparatus is accessible, and the filters may be easily renewed when requisite. The performance is very perfect.

2900. *Water contaminated by salts of any kind cannot be easily deprived of them.* Filtration in this case has no effect whatever; and persons who have proposed apparatus for separating salt from water by this process have been totally ignorant of chemical principles, since all salts dissolved in water pass readily through the filters. Neither can any kind of mechanical compression through sand separate the salt from water, as some have erroneously imagined. To render salt or brackish water fresh, other methods must be resorted to; but any chemical re-agents that may be employed to precipitate

salts from water must themselves remain in the fluid, and constitute another kind of impurity.

2901. *Distillation is the only effective process by which the water may be obtained quite pure;* but in general this would be too expensive and tedious for ordinary purposes. At sea, where fresh water is absolutely necessary, the distillation of sea water is frequently employed, as we have shown, in order to deprive it of its salt.

2902. It is very important to understand the difference between salts and the soluble parts of animal and vegetable bodies. The former continue in the water without any particular action, and they can be separated by chemical means, or by distillation; but the soluble parts of animals and vegetables decompose and pass into the putrefactive state, giving out gases and other volatile products, which are taken up by the water, and communicate to it highly deleterious properties, some of which are not yet understood, such, for example, as that which generates malaria, giving rise to marsh fever. Such animal and vegetable substances may be in a great measure, or entirely, separated by filtration, if that method be employed before the substances are decomposed or dissolved in the water; but after that there is no method of depriving the water of them completely, with such ease that it can be practised as an affair of domestic economy: we have stated that charcoal effects this purpose partially. Such water as contains much animal or vegetable matter is extremely liable to pass into the putrid state.

2903. *The importance of good water on long sea voyages is obvious;* yet, notwithstanding the great care that is usually taken to select the purest that can be got, it frequently happens that, when long kept, and particularly in wooden casks, it undergoes a kind of putrefaction, and becomes unfit for drinking. The cause of this change depends upon the impurities contained in the water. Water that has been naturally filtered through sand, and which does not contain salts, is generally the fittest for being carried to sea; but frequently, from local circumstances, the water of rivers is employed.

Some rivers that do not take their rise from a rocky soil, and which become considerably charged with foreign matter during a long course, even over a widely cultivated plain, are remarkably free from saline contents, but are often fouled with mud and vegetable and animal exuviæ, which are rather suspended than held in true solution. Such is that of the Thames, which, taken up at London when the tide is down, is soft and good water; and after rest and filtration it holds but a very small portion of anything that could prove noxious. It is excellently fitted for sea store, but, after being some time at sea, it undergoes a remarkable spontaneous change. When a cask is opened that has been kept a month or two, a quantity of inflammable air (carburetted or sulphuretted hydrogen) escapes, and the water is very black and offensive. Upon racking it off, however, into large earthen vessels, and exposing it to the air, it gradually deposites a quantity of slimy mud, becomes as clear as crystal, and remarkably sweet and palatable. This effect is owing to the water having contained originally a good deal of impurities, consisting of animal and vegetable matters, which putrefy and decompose, and, in consequence, give out the gases and offensive smell above mentioned; but as soon as the decomposition of all these substances has been completed, and the fermentation has subsided, the water is pure in consequence of having thus got rid of them. Hard waters which contain sulphate of lime become more offensive than those which contain only carbonate of lime, for the former salt decomposes, and its sulphuric acid gives rise to sulphuretted hydrogen, which has the most disagreeable odour.

2904. It would appear that the soluble vegetable matter of the wooden casks formerly employed in the navy contributed to the putridity of the water; for now that iron tanks are substituted for them, the water may be kept much longer without being offensive. The metal becomes oxydized, and the oxyde of iron thus formed mixes with the water, but by its weight and insolubility it soon falls down; or, should a small portion remain in the water, it can have no injurious effect upon health. It might be supposed that this fermentation of the foul matter in river water might be resorted to in order to purify it for the purposes of domestic economy; but this method would be by far too tedious, and nearly the same effect is produced by filtering through charcoal.

2905. *Alum is sometimes employed in purifying muddy water,* which it does in some measure when there is a small quantity of impure organic matter. If alum be added in the proportion of a few grains to a quart of foul water, with agitation, and then suffered to rest for twenty-four hours, a sediment will fall down, the water will become clear, and may be poured off. Here the alum combines with the impurities, as in the case of dyeing, and occasions them to subside. If any alum should remain dissolved, and not combined in the water, a little carbonate of soda may be added; this will decompose the alum, the soda making, with its sulphuric acid, sulphate of soda, or Glauber's salt, which remains dissolved after the rest has been precipitated. A few drops of a solution of the red sulphate of iron added to a pound of water will produce the same effect.

2906. *A patent was lately taken out by Professor Clarke, of Aberdeen,* for a method of purifying water by adding quicklime to it. But this can only unite with any carbonic acid that may be in water, forming carbonate of lime, which will be precipitated along with any carbonate of lime that may have been in the water; out it can have no effect upon the sulphate of lime in water, which is the chief cause of its hardness.

2907. *In many parts of Hindostan the water is very impure,* being wholly preserved in tanks. In that country, a most valuable plant, *Strychnos potatorum*, or the cleansing nut, is said to have the property of purifying the water. The pulp of the fruit, when ripe, is eaten by the natives, and the seeds are dried and sold in every market for this purpose. If one of the seeds be rubbed hard for a minute or two round the inside of the vessel before the water is put in, the fluid, however foul, will, a short time being allowed for it to settle, be freed from all its impurities, the adventitious matters being settled to the bottom, and the supernatant water left clear

and perfectly wholesome. These nuts are constantly carried about by the more provident part of our Indian officers and soldiers in time of war, to enable them to purify their water; they are more convenient than alum, and are, perhaps, more wholesome. It may be mentioned as a curious fact, that the fruit above mentioned, having the property of clearing muddy water, is the only safe species of a large tribe of plants which are virulent poisons.

Sect. XII.—Chemical tests for examining water.

2908. We stated, under the head "Building" (Book I.), how essential it is to have a supply of good water; and that, if no well existed on the spot where a house is to be erected, it was desirable to sink one for the purpose. The salubrity of water being a matter of the first importance to health, it is proper that what is obtained from this or any other mode of supply, where its purity may be questionable, should be carefully examined before it be used for the usual purposes of domestic economy.

2909. *When good water is first taken up it is perfectly clear and colourless*; but the examiner should not be satisfied with holding up a glassful between his eye and the light; he should also pour some into a deep ale glass, into which he should look downward, when the slightest tinge from extraneous substances will appear.

2910. If the water be discoloured in any manner, it is usually owing to some impurity mechanically suspended in it, and which may be removed by rest and filtration, in the manner already described; but the impurities may likewise be dissolved in the water, in which case they will pass through the filter, which has no power of separating them.

2911. *The existence of various substances dissolved in water* may be discovered by the use of what are called *chemical tests* or *re-agents*. These are substances made and kept for this purpose; by the addition of a small portion of one of these tests the presence of a particular substance in the water may be detected. But although it is extremely easy to detect, in this manner, the substances most usually found dissolved in water, yet the complete examination of this fluid, so as to ascertain all the matters that are contained in it, is a subject that requires a very considerable acquaintance with practical chemistry, the analysis of waters being one of the most difficult and delicate of chemical researches. It would be quite out of place here to attempt an explanation of this subject at any length, and we only propose pointing out the methods of ascertaining the presence of those substances with which spring or well water are most generally contaminated, and which cannot be removed by filtration.

2912. *If the water obtained should be so impregnated with salts* of any kind as to be readily discovered by the taste, it would come under the description of a mineral water, and be altogether unfit for domestic purposes; but if it be transparent, colourless, and free from any peculiar taste, it is probably good: nevertheless, it may be hard, for the hardness would not affect its transparency, nor would this be readily discovered by the palate, except that organ had been much practised in tasting waters. Using the water in washing will determine this point to a certain extent: if it makes a good lather readily with soap, it is soft; if not, it is hard.

2913. *The nature of hard and soft waters* has been detailed at such length when treating of "Spring Water," that it would be a useless repetition to describe it again. We shall here, therefore, content ourselves with giving more particular directions for employing the tests.

2914. *The mere fact of hardness may be ascertained* by a solution of soap in spirits of wine, which is the method usually employed by well-diggers. If this be dropped into distilled water, no alteration will occur; but if the water be hard from an earthy salt, the solution of soap will occasion a white flocculent adhesive precipitate, which is owing to the lime in the water uniting to the fat of the soap, the alkali of the latter having joined the sulphuric acid of the lime. This test, however, only proves there is some neutral salt in the water, but does not point out what that salt is. Most salts, however, except those which are calcareous, are discoverable by the taste, particularly if part of the water be evaporated.

2915. *To determine whether the water contains lime* in any form, the *oxalic acid* should be employed, as the best test for this earth. All waters containing lime are more or less injurious to health, affecting the kidneys if they are drank for any continuance. Some of the springs about London contain a great deal of sulphate of lime, and are unfit for washing, and would be unhealthy to drink. To explain the principle upon which oxalic acid proves the presence of lime, it must be observed that lime has a stronger attraction for the oxalic than it has for any other acid; therefore it will quit whatever acid it may be combined with in a dissolved state, and unite to the oxalic, forming an oxalate of lime, which, being insoluble in water, will fall down as a white precipitate. But, instead of using pure oxalic acid, it is better to employ it as joined to ammonia, or the *oxalate of ammonia*.

2916. *To detect the presence of iron in water*, add to it *tincture of galls*; if there be iron, a black precipitate, like ink, will be perceived; but for this purpose the water must not be boiled, for in that case the carbonic acid would be driven off and the iron would fall down, and would not be affected by the test. *Prussiate of potash* in the same case will give a blue precipitate, like Prussian blue. If this test give the same coloured precipi-

tates after the water has been boiled, then the iron is not in the state of a carbonate, but is most probably a sulphate of iron. If it be required to determine whether the salt be a sulphate, add muriate or nitrate of barytes to some of the water, and if it be a sulphate, but not otherwise, a precipitate will appear.

2917. *Sulphuretted hydrogen is easily known* in water by its disagreeable smell, like that of rotten eggs, or by blackening a silver spoon put into it.

2918. *Carbonic acid in a free state* may be conjectured by the brisk, sparkling appearance of the water, and this being destroyed by boiling; but it is accurately ascertained by the water reddening *litmus paper*, and precipitating barytes water before boiling, but not after it is boiled.

2919. *Vegetable or animal matter may be detected* by adding sulphuric acid and evaporating the water; if such matter be present the water will become blackened.

2920. The above are the substances most usually found in water; others, which are more rare, require considerable knowledge of practical chemistry to apply the tests properly.

2921. *From all this we may perceive the necessity of having a chemical analysis made of water* about which we have any doubt, and which is to be used for any important purpose, as in the case of water from newly-sunk wells. But this, as we have already observed, can only be effected by the skilful practical chemist.

Sect. XIII.—On tanks and cisterns for preserving water.

2922. *In some countries, where springs are scarce, and where it rains only periodically*, great care is bestowed on reservoirs or cisterns erected to preserve water. Anciently there were cisterns all over the country in Palestine; these are frequently referred to in Scripture, and many of large dimensions are still to be seen. As the cities were, for the most part, built upon hills or high ground, and the rains fell in India at two seasons of the year only, in spring and autumn, people were obliged to keep water in cisterns in the country for the use of their cattle, and in cities for the convenience of the inhabitants. Ancient subterranean cisterns are described as still to be seen at Constantinople, the vaults of which are supported by several hundred pillars. In modern times, before the discovery of such excellent cements as we are now possessed of, there was considerable difficulty in building cisterns to hold water; at present, from the perfection of our Roman cement, this has become comparatively easy. Bricks laid in Roman cement, and covered on the inside with a coating of that material, form a wall perfectly tight, and impervious to water.

2923. *The choice of a material for reservoirs* in which water is to be preserved for drink or culinary purposes is extremely important. The material which has long been, and is still, generally employed for common cisterns is lead.

2924. *The deleterious effects of lead* dissolved by various substances and taken into the stomach is well known; but it is necessary to adduce proofs of it in this place. Water absolutely pure has no action on this metal if air be excluded; but, if air be admitted, its action is very sensible. In the atmosphere there is always present a certain proportion of carbonic acid, and most waters likewise contain a minute quantity. The carbonic acid acts upon lead, and converts it into carbonate of lead, which is a poison. A white line may generally be seen at the surface of water preserved long in leaden cisterns, where the metal touches the water, and this is owing to a deposition of carbonate of lead, formed at the expense of the metal. Waters differ much in the power of dissolving lead. Some act upon it with great rapidity, as is evinced by the corrosion of the cisterns and pipes. But the consequence of this is not generally appreciated.

Dr. Lamb, who has paid much attention to this subject, and to whom we are indebted for many valuable facts, states an instance where the proprietor of a well ordered his plumber to make the lead of a pump twice as thick as what is usually employed for such a purpose, in consequence of his observing that it was frequently corroded and required constant repairs, not considering that the lead thus quickly dissolved was poisoning his water.

Nothing is more certain than that lead cisterns and pipes become leaky from the chemical action of the water upon them, and it must be equally obvious that in all such cases the water is contaminated with a portion of active poison. This action of water on lead is increased frequently by the circumstance of vegetable matter, such as leaves, falling into the cistern; this will impart to the water an additional solvent power, which points out the propriety of at least keeping cisterns extremely clean where lead happens to be the material employed.

It may be supposed that the quantity of metal thus dissolved, and still more the portion that is actually taken into the stomach, must be too minute to deserve serious attention, and that its effects cannot be appreciable. But, considering the complicated nature of the human frame, it is neither impossible nor improbable that a very minute portion of a deleterious substance taken with our aliment for a length of time may exercise an injurious influence after a series of years, although this effect may not be perceived in a short period. We find this to be the case in the use of spirituous liquors, and in other

destructive habits. From a passage in Vitruvius, an architect of the time of Augustus, we learn that the ancient Romans were acquainted with the deleterious effects of lead; and he condemns the practice of conveying water in leaden pipes, as this metal, he observes, renders the water insalubrious; but it is observed that water has no action on lead pipes if they are kept always full, since thus the air is excluded.

It would appear, therefore, to be a matter of common prudence to avoid, as much as possible, the use of metal so dangerous as lead in forming cisterns and reservoirs; or, at all events, if it is employed for this purpose, care should be taken to clean such cisterns or other vessels frequently, and not to suffer any water to remain long in them without being changed. It has, indeed, been confidently stated by physicians that a dangerous, and even fatal colic has attended persons who have been obliged to use for some time water which has been contaminated by lead from pipes and cisterns; and that, when pipes of wood, earthen-ware, or iron were substituted, the water ceased to produce these dreadful effects. Dr. Paris mentions several cases of this kind.

2925. *A very delicate test for the discovery of lead in water* is sulphate of potash, or sulphate of soda, which, Dr. Thomson informs us, will detect it, even should it not exceed one part in 100,000 parts of water. A drop or two of this test in a glass of water will show the presence of lead by a cloudy precipitate.

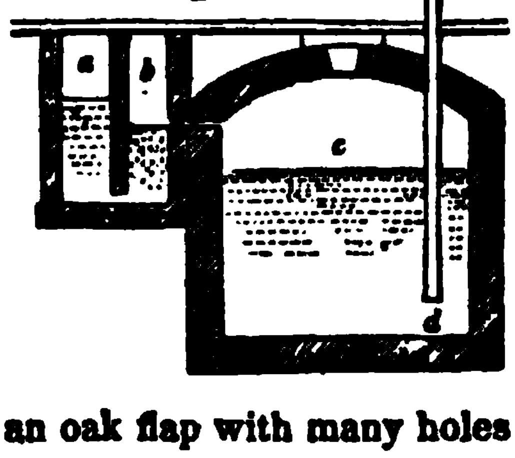
Notwithstanding, however, the opinion which we have just expressed on the impropriety of using lead in general for conveying and preserving water, there is *one case* which forms a remarkable exception to the principles we have stated. It was first shown by Guyton Morveau, and afterward more particularly by Dr. Christison of Edinburgh, that the presence of saline matter of some kinds in water retards the oxydation of lead; and that some salts, even in very minute quantities, prevent it altogether. Such waters, therefore, as have dissolved in them a portion of these salts may be safely conveyed and kept in that metal. Thus a small quantity of muriates and sulphates, which exist in many kinds of spring water, preserve lead from corrosion. "In water containing these," observes Dr. Turner, "the metal gains weight during some weeks, in consequence of its surface gradually acquiring a superficial coating of carbonate, which is slowly decomposed by the saline matter of the solution. The metallic surface being thus covered by an insoluble film composed of the salt and the lead adhering tenaciously, all farther change ceases." The water of Edinburgh has this property; and, likewise, all waters which are hard, though containing sulphate of lime. But no soft water, such as rain water, possesses this advantage.

In recommending that lead cisterns should be frequently cleaned, we must remark that we do not advise that they should be scoured bright; for this would, by exposing the pure metal to the action of the water, occasion it to be more readily dissolved, and destroy the protecting crust; but by cleaning we mean only removing the mud and other loose impurities that may have settled to the bottom, or be attached to the sides, for which brooms and brushes are sufficient.

2926. *In treating of rain water*, we mentioned the possibility of obtaining a sufficient supply by means of a roof properly constructed, a circumstance of great importance in places where wells or springs are scarce.

2927. *Tanks for rain water* have been long employed in some parts of England, particularly in the Isle of Thanet and in Berkshire. They are sunk in the ground, and are of a cylindrical form, resembling a shallow well. The best lining is brick laid in Parker's cement, or very strong mortar, and covered with a coat of cement half an inch thick. It will be best to cause the water to run through a large filter of sand and charcoal previously to passing into the tank. The tank should be arched over with a flat dome of brick, having an opening to clean it out when required, which may be closed by a stone. If the water be first filtered, there will be very little deposite. A pump may be fixed in the tank to raise the water. By means of such a tank almost every house might be supplied with soft and pure water.

Fig. 538.



2928. The annexed wood-cut (*fig.* 538) exhibits a section of the arrangement of this tank with its filter. *a* is the division of the filter into which the rain water is conducted from the roof by a pipe; from this it passes below the partition in the middle, between *a* and *b*, rises through the sand and charcoal in the division *b*, and passes through an aperture into the tank or reservoir, *c*, where it is preserved till raised by a pump, *d*. The top of the tank is arched with brick-work, and has a man-hole to clean it by, covered with an oak flap with many holes bored in it for ventilation.

2929. *Tanks easily and cheaply constructed* have been lately formed at Eastbourne, in Sussex. These have been eminently useful during the last dry summers; they are not liable to decay like wooden vessels, and take up little room.

These tanks vary in size; one of less than seven feet wide has served two labourers' families for three years, while most of the springs in the neighbourhood were dry. A tank, twelve by seven feet, has been found sufficient to supply with water a large family and six horses; this was surrounded by only four and a half inch

brick-work, and covered in upon the Egyptian plan, by making each row project one third of their length inward before that below it, filling up the back with earth as the building was proceeded with, in order to balance the weight of this overhanging brick-work. At the Eastbourne Workhouse a tank has been made, twenty-three feet deep by eleven wide, of the roughest materials, being only flints of the chalk; and, though they require more mortar than if they had been regularly shaped, only ninety bushels of lime were allowed, including two coats of plaster; and the workmanship is executed like field walls at 10s. per 100 square feet, taking care that no clay be used (as worms in time bore through it), and that the Parker's cement be good.

A current of air is said to promote the purity of water in tanks, which is easily effected by the earthen-ware or other pipe which conveys the water from the roof being six or eight inches in diameter, with an opening left in the tank. When the prevailing winds do not blow leaves or soot on the roofs, the water will remain good, even for drinking, without clearing out the tanks above once a year; but in some cases filtering by ascension has been found useful, and effected by the water being delivered by a pipe at the bottom of a cask or other vessel, from which it cannot escape till it has risen through the holes in a board covered with pebbles, sand, or powdered charcoal, as described above.

2930. *The use of such tanks is farther shown* in converting the water that used formerly to injure a public road to the purpose of watering twenty labourers' gardens, by which good crops of potatoes were obtained, when sets not watered failed. Tanks or ponds dug in the chalk four feet deep, what is excavated being added to the sides roofed over, have been found very valuable for the large flocks of sheep in the south downs. Cisterns built with brick and cement, for preserving the rain water from roofs for domestic purposes, are very common in the Ridings of Yorkshire.

2931. *For cisterns on a small scale, for the use of the house, slate is found to be excellent material.* Welsh slate is sawn into thin slabs, and put together with cement, as in the annexed woodcut (*fig.* 539). The ends *a b* are let into groves in the sides *c d*, the latter being held and pressed together by the iron rods with screws and nuts, *e f g*. The bottom is likewise fitted in a groove; thus the whole is kept together in a manner extremely simple.

This kind of cistern is very durable, not being liable to get out of repair; and it has the advantage of not in any way affecting the water like lead. A waste-pipe is necessary, of course, as in every other cistern, for this purpose. As slate is liable to be broken by a heavy blow, it may be necessary, in some instances, to provide a wooden casing, or at least a front of wood.

Cisterns of slate may be easily made with a partition, so as to filter all the water that is put into them in the manner already shown.

2932. *The common receptacles for water in small houses* are wooden casks or butts, and these have often been previously used as beer or wine casks. All wood is apt to communicate some unpleasant flavour or odour to the water, except they are charred inside, which they ought to be; and it is too commonly the case that they are left uncovered, and then the water is liable to be contaminated by various substances floating in the air, and by insects of various kinds. They should be frequently cleaned out, and kept carefully covered.

2933. *A ball-cock* is an excellent contrivance, which allows the water to come into a cistern, but shuts of itself when the cistern is full; hence they are always employed in the cisterns supplied by water companies. The plug of this cock is kept in by a screw, or rivet, in the usual manner; it has a copper rod fastened to it, to the other end of which a globular ball of thin copper plate is soldered. This ball is so light as to float upon the water of the cistern, and when it hangs down, the cock is open and the water comes in; but, as the water runs into the cistern, it raises the ball and shuts the cock, thus stopping the supply to prevent it from running over. Though this contrivance is very simple, it is sometimes apt to be out of order, and therefore should be frequently examined.

2934. *Every cistern should also have a waste-pipe*, which is a pipe fixed perpendicularly in the bottom of the cistern, having its upper orifice exactly at the level at which it is desired the water should be when the cistern is full. If by any accident the ball-cock should be out of order, or if there is no ball-cock, the superfluous water, that would otherwise overflow, will pass down the waste-pipe.

2935. *Ponds or reservoirs for collecting and preserving water* are frequently necessary for the use of cattle and other purposes in rural and domestic economy, in places where there are no streams or lakes, and these are usually dug out of the ground. It is not difficult to make a pond in a clayey soil, as it is of itself retentive of water, but in cases where the soil is of a loose and porous nature much more care is necessary. It is found, however, that a coat of tough clay, well beaten and rammed in, called *puddling*, is generally sufficient. In some parts of the kingdom, as on the Yorkshire wolds, there is no water for cattle or sheep, except what is collected from rain, and preserved in ponds constructed for this purpose, and they are found to be extremely useful in sheep-walks. The method employed there appears to answer the purpose perfectly, and is as follows: The ponds are made circular, and about forty and fifty feet in diameter, and the excavation is not made above five feet deep in the centre. After the excavation has been cleared out, a layer of clay, well tempered with a little water, is laid over the whole of the bottom, and trodden down and beat with beetles till it forms a compact body of about the thickness of a foot. Upon this a layer of quicklime, of an inch or upward in thickness, is uniformly spread. Over this is put another layer of clay, similar to the last, and trodden down in the same manner. To prevent this clay from being injured by the treading of the cattle, the whole is covered with a layer of coarse gravel or small stones, of such a thickness that the feet of the cattle will not break through it. Some pave the part of the margin by which the cattle enter, which is a good practice, as it is important that the water should be as clean as possible. The use of the layer of lime does not appear to be

thoroughly understood; whether it unites with the clay, forming a kind of hard cement, or whether it acts in preventing the worms from boring through the clay, which they are known to do where clay alone is used, and thus let out the water; but it is observed that this mode of construction answers better than where lime is not employed. An improved method of executing this part is to make a mortar by mixing the lime with sand, but it adds a little to the expense. Though tough clay is best, yet it does not appear to be absolutely essential; and any earth sufficiently tenacious to bear beating into a solid, compact body, will answer the purpose, though not so well. Paving the whole bottom of the pond will, where the expense and trouble are not an object, be the most complete method.

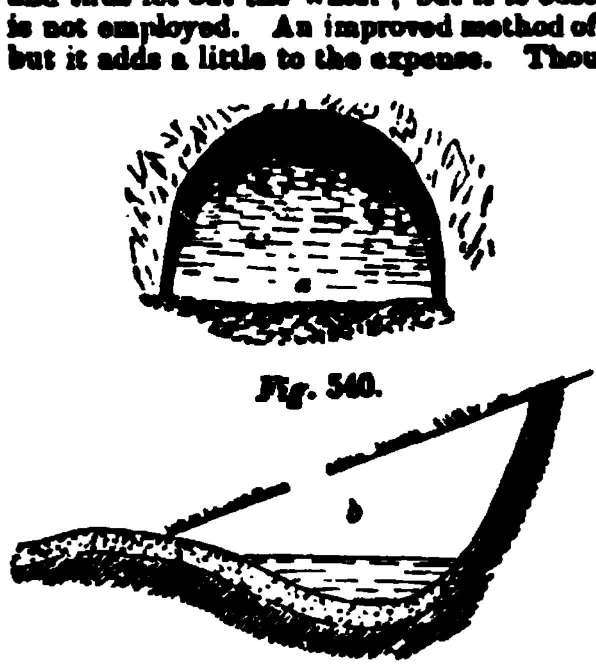


Fig. 540.

2936. *When a pond is to be made upon the slope of a hill*, the form may be a semicircle, as in the ground plan *a*, *fig.* 540, or the segment of a circle. The upper side must be steep, and the lower one of a proper slope for cattle, the bottom being formed out of the materials dug from the hill, as is shown in the section *b*. One pond may be made to supply two or more fields by placing it so that the boundaries of the fields may pass through the pond. Trees should not be planted round ponds or open reservoirs of water, notwithstanding they shade the water from the heat of the sun, and the agreeable effect which they produce, for the leaves which fall into the water, by their decomposition, injure the quality of the water; and such ponds should be frequently raked and kept from aquatic plants, particularly those minute confervæ like green slime, which are very apt to collect in standing water. One great use of paving the whole bottoms of ponds is the facility which this affords of keeping them clean.

2937. *In cases where a pond is supplied by water which runs down sloping ground*, a great deal of impurities is frequently brought along with it, which would render the pond muddy, besides tending to fill it up. It would then be proper to admit the water into another reservoir previous to its entering that from which it is to be used, in order that it may first deposite all its sediment, and the latter will be found extremely useful as manure. The communication may be made by a pipe laid at the surface of the first reservoir, and having its mouth covered with a grating or a plate pierced with holes. As the health of cattle, as well as that of human beings, must depend, in a considerable degree, upon the salubrity of the water which they drink, it would appear proper that more care should be taken to keep the water of ponds in a clean state than is generally bestowed; and a drinking fountain, raised a little from the ground, formed of stone, and kept quite free from weeds, into which the water might flow, filtered from the pond, would not be very difficult to execute upon the principles which have been explained above, and might be a most agreeable object in pasture ground. This latter idea is the more important, since the loose stones with which ponds are covered, as described above, are frequently forced deep into the clay by the feet of the cattle, and the pond is thereby materially injured; besides, sheep are often disgusted when the water is thus rendered muddy, and refuse to drink it.

It is of the greatest consequence that sheep and cattle should be supplied with *pure water*, particularly during the heat of the summer months. For this purpose light, running water is to be preferred where it can be obtained, or, if possible, well water in troughs or shallow tubs, which is very requisite when sheep are confined in folds; but on no account should they be allowed to drink water that has been long stagnant, or in a tainted state, as it must be when it contains any dung. On the Continent the watering of sheep is regarded as a circumstance of the greatest moment. At the best establishments in Sweden and France they are daily watered with running water, or with that obtained from lakes or springs, which is conducted to them by means of pipes into troughs, out of which the animals drink at pleasure, and, consequently, take less water at each time, which is favourable to their health.

2938. In situations where there are natural inequalities of level, it will be easy to construct the pond itself higher than the drinking place, into which it is to be conveyed by a pipe; but where the place is perfectly flat, and the reservoir is to be filled with water collected only from rain, it may be found best, instead of sinking a pond in the earth, to erect extensive low sheds covered by roofs proper for collecting rain water, which might be discharged into the reservoir on the ground; and it has been already shown that any required quantity may be collected by means of roofs. In the best farmeries horses are now more frequently supplied with water, and washed by means of troughs of clean water in the stables, than driven into the pond as formerly.

2939. *The water collected in draining land* may, in some cases, be rendered available for some purposes of domestic economy by conducting it to tanks or other places, where it may first be depurated by deposition, and afterward, if necessary, by filtration. In this case, as much of the drain as possible should be made of drain tiles or earthen-ware pipes. Water so collected has been employed in turning mills and performing other work.

Sect. XIV.—On Pipes for Conveying Water.

2940. *Pipes for the conveyance of water* are made of wood, iron, copper, stone, or pottery.

2941. *Wooden pipes* are the least expensive at first, and are easily made; they are best bored in trees of the proper size, and then the bark being left on preserves them. If small, the passage may be bored by a long auger, turned round by one or two men; but where the pipes are large, and the demand is great, as for supplying towns, machines are employed to bore them. The great objections to wooden pipes are, their want of strength to resist a great pressure of water, and their liability to decay. They are usually made of elm or alder; oak would be preferable, if it were not too expensive. The lengths of pipe are fitted in by enlarging the bore at one end in a conical form with a sort of auger, and cutting the opposite end taper to drive into the conical end of the adjacent pipe, which is hooped to prevent its splitting. Great care should be taken in fitting them well together to prevent leakage, and not to cut away too much of the wood at the taper end, which is frequently the cause of decay. Wooden pipes are apt to generate insects in their decayed and rotten parts, and water lying long in such pipes becomes putrid from the animal and vegetable matter collected in them.

2942. *Cast-iron pipes* are superior to any other for durability and strength. They may be procured of any diameter in lengths of ten feet, and then are united by means of nuts and screws passed through flaunches cast on them; these require to be put together with some cement. After having screwed the pipes together, they first calk the joint with hemp, and then fill it up with a composition of borings or turnings of cast iron, mixed with sulphur and sal-ammoniac, and moistened with water. The rapid oxydation of the iron unites the whole into one mass, and at the same time expands the bulk of

the cement, so as to fill up the space very closely. The use of the hemp is only to prevent the cement from getting into the inside of the pipe. Some have used Roman cement for this purpose; and others have employed melted lead. An idea has sometimes been entertained that the iron is injurious to the salubrity of the water; but a thin black oxyde soon forms upon the inside of the pipe, and defends it from the action of the water, forming a sort of black japan. If the water contains lime, the latter is deposited as a fine crust over the inside, and defends them from corrosion; and there is no fear that iron pipes will fill up with this deposite, since the water only deposites the stony matter from the attraction of the iron, which, being once covered with a slight thickness, the water no longer has access to the iron. Some have put lime into the water purposely at first, when it was found that the water was so corrosive as to become tinged by running through iron pipes newly laid down; a rapid current of lime water being passed through the whole length for a few days, the pipes became coated in the inside with calcareous matter. At first, after this, the water tasted of lime, but it became pure in a short time.

2943. *Stone pipes* have been used; and they are perfectly safe and wholesome, but difficult to execute. Machines have been invented for sawing them out of blocks of stone; but the expense was too great, and they were liable to break.

2944. *Copper pipes* are never employed, except in particular cases, in machinery and apparatus of various kinds.

2945. *Lead pipes* are universally employed for small water pipes, chiefly from the facility of bending them in any direction, and soldering their joints. They were formerly made of sheet lead wrapped round an iron or wooden core, and the joint soldered up. This method was imperfect, as they were apt to give way in the joint; they are now generally made by casting the lead in an iron mould, upon a cylindrical iron rod of the size of the bore of the intended pipe, the lead being three or four times the thickness of the intended pipe, and in short lengths, which are then drawn through holes in pieces of steel in the manner of wire-drawing, till the pipe is reduced to the intended thickness, and drawn out to the proper length. We have already mentioned the bad effects of keeping water long in lead.

2946. *Lead pipes lined with tin* have been made for the conveyance of water where it was in danger of receiving a taint from the corrosion of lead, or for beer.

2947. *Pipes of pottery-ware* are made of a coarse, brown kind of pottery, which is very hard and durable; they can only be made in short lengths, and have one end enlarged to receive the other. To close the joints, tow and pitch are used. These pipes can never be made to bear much pressure, are liable to be broken by accident, and are expensive; but they preserve the water perfectly pure. It appears from some ancient buildings that the Romans sometimes made use of them.

2948. *Pipes are subject to obstructions*, not only from the deposition of sand or mud in the lower parts, where they are curved, but also from air which gets in by accident, and separates from the water, and collects in the upper parts of their bendings. To clear a pipe of this air, if it be of lead, the common method practiced by the plumbers is this: they drive a nail into the place where they suspect the air to be lodged, and while the nail is in, they hammer up the lead round it; they then draw out the nail and suffer the air to escape; when that is all gone, and the water appears, they, with a stroke or two of the hammer, close up the hole in the pipe again, which the lead gathering round the nail enables them to do.

Sect. XV.—Forming wells and raising water.

2949. When water cannot be procured on the surface of the earth, it is necessary to search for it in the interior, where it circulates in numerous places. The origin of well water was shown in Book VIII., Chap. I., Sect. V. Two methods are resorted to for reaching it: digging wells, and boring the earth.

2950. Considerable difficulty is experienced in fixing upon the spot where it is likely that water may be obtained by sinking a well; and much judgment is required, as the operation is very expensive.

2951. *Well-digging* is performed by persons who pursue this avocation exclusively, as it demands peculiar knowledge and practice. The form of wells is always circular. If they should happen to be formed in chalk, no stone or brick lining is necessary; but if made in soft strata, which is most frequently the case, to prevent this from falling in, they are lined within with bricks laid without mortar, which operation is termed *steening*. The steening of a well is a mode of building rather curious, as the internal wall is built and sinks down as the well proceeds. In beginning it, a few feet from the surface a ring or circular curb of wood, called a barrel curb, *a b c d*, *fig.* 541, the size of the well, is laid on the bottom of the digging, and bricks built on it, shown at *c a*, all round, to a considerable height; the well is then proceeded with, and the well-digger cautiously digs away the earth at *d* and *b*, from below the curb, which by degrees sinks down from the weight of the brick-work upon it. When the curb has got to the lowest part of the well that is being formed, the latter is again carried some way far-

ther down, and again the curb and the steening are lowered by the same process as before. This curb is left in the well. If the depth is very great, and the steening will not sink any farther, sometimes they form a new curb within the first, and cause that to sink as they proceed. When they arrive at a spring, it will sometimes burst out with great violence, so as to endanger the safety of the well-diggers, who are then drawn up with all expedition. The depth at which water is found varies in every situation, according to the geological structure of the country. This latter branch of knowledge affords the only clew by which the probability of finding water, and at what depth, can be conjectured upon rational grounds; and well-diggers unacquainted with this useful science can prognosticate only from a kind of knowledge and practice of a very limited nature, and are extremely apt to mislead their employers, not always from dishonest motives, but frequently from a total misconception of the true principles upon which they ought to proceed. The thickness of the steening is generally four inches, or half a brick, and the well should be domed over with brick-work, leaving a man-hole twenty inches square, covered with a Yorkshire stone, having a strong iron ring let in in the top to lift it out by. It is usual to contract with the well-digger for a certain depth, that at which water is expected, paying him as extra if the depth should exceed, or deducting if it should fall short of, what is supposed.

Fig. 541.

2962. *Boring the earth to obtain water* has, of late, been practised with great success, not only in this country, but on the Continent, and in many other parts of the world; and it is found to be a very great saving of expense. In consequence, many places are now supplied with this useful fluid where formerly it was entirely wanting. The operation is extremely simple. It consists in fixing an auger or other boring instrument to long iron rods screwed on to each other, which are turned by the action of men with a crowbar. The operation is usually begun by digging a well six or eight feet deep, in the centre of which the boring instrument is placed. The nature of this instrument depends upon that of the stratum to be penetrated, and it is changed accordingly when a stratum of a different degree of hardness is arrived at. Soft clay, or loose, sandy soil, is penetrated by an auger in the form of a hollow cylinder, with a longitudinal slit, *a*, *fig.* 542, or without a slit. This auger is screwed into the rod with a cross-handle turned by the men. If the ground is very hard, a chisel, *b*, is screwed to the rod, and is turned round in the same manner. But, to assist the action of this tool, an elastic pole, *c*, is connected by a chain with the borer, and made fast at one end, while a labourer keeps continually giving to the other end an up-and-down motion, which, corresponding to the beating motion of the men below, helps to diminish their labour. When the ground is thus perforated as far as the chisel and its rod will go, they must be withdrawn, in order to introduce a cylindrical auger, *d*, which has a valve within opening upward; this, passing through the rubbish loosened by the chisel, brings it up as it rises up through the valve, but cannot return. Sometimes an auger like *e* is used, consisting of a hollow cone, having a spiral, cutting edge winding round it. Tools of other forms are likewise employed to suit particular purposes. In order to raise the rod with the auger when required, either to change or to take out the loose matter, a standard is made with three poles over the well, to which a tackle is fixed. The usual length of each rod is about seven feet, and length upon length are screwed together as the boring proceeds. The chisel is generally about four inches wide, and the gouge three inches and a quarter. Raising the rods and displacing them is effected every time the auger has to be withdrawn, which occupies a considerable time. If they meet with rocks, the labour is much increased, as they can get through only by repeated beating the tool up and down to pulverise them. When they arrive at the spring of water which has been expected, the hole is made smooth by passing up and down a rod for this purpose, and a pipe made of tin or other metal is forced down in lengths, which are soldered together as they go down. This keeps the hole open, and prevents the admixture of water from any of the small springs in the side. Upon the whole, the boring is performed with more facility than could be imagined by those who never tried it.

a b

Borings are now made to the depth of several hundred feet, which supply a plentiful stream of water. If the original source from which the water comes be higher than the surface of the ground where the boring is made, the water will overflow; but if the source be at a lower level than the boring, then the water will not rise to the surface of the ground, and it will be necessary to dig a well to the depth to which the spring will rise; and this well serves as a reservoir to contain the water, which must be raised to the surface by a pump.

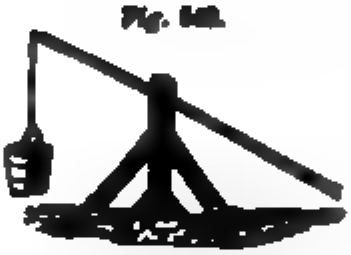
2963. When a well is formed, it seldom happens that the water rises quite to the surface of the earth, and it is then requisite to have some contrivance by which it is made to reach that level.

A great variety of methods of raising water from wells has been practised at different times and in various countries, each of which may have some convenience or advantage according to the locality and other circumstances.

2964. *The lever and bucket* (*fig.* 543) is one of the most simple of these. A long pole,

supported by a post, acts as a lever to raise the bucket, and from the end of the lever the water may be raised even by a child by a very trifling exertion. This method is common among the market gardeners near London; but it is only calculated for those cases where the water is very near the surface. It has the advantage of the greatest simplicity, as it can be constructed by any person that can make the lever and upright post.

Fig. 543.



2955. *The next method is the bucket raised by a windlass, fig.* 544. When the well is very deep, or a great supply is wanted, this may be assisted by machinery turned by any of the ordinary powers.

Fig. 544.

2956 But the most convenient method of raising water is by means of *pumps*, which will be described under "Kitchen Furniture," Book XI., Chap. III.

2957. *An old but ingenious mode of raising water* from a well to the upper part of a house is sometimes adopted on the Continent. A post is fixed close to the well; this is connected by a fixed cord with the window or other opening in the upper part of the house where the water is to be introduced. On this cord a wooden collar is placed, and slides freely from one end to the other: the bucket-rope is put through the hole in the collar, and over a pulley in the window, and thus the bucket is raised, first perpendicularly from the water in the well till it comes in contact with the collar, when, the power being continued, the collar slides along the fixed rope, till, together with the bucket, they reach the operator in the window.

2958 It may be proper briefly to notice a few other simple methods of raising water from one level to another, which are occasionally employed.

2959. *Chain of Buckets.*—This consists of a number of buckets fastened to a chain or rope, the two ends of which are united; the chain goes over a wheel, and hangs down into the well, with its buckets having their mouths downward as they descend On arriving there, the buckets become filled with water, and by the turning of the wheel and the motion of the chain they are brought up, while those on the other side of the chain go down empty.

2960. *The Spanish noria* is a chain of buckets or earthen jars, generally worked by an ass.

2961. *When large buckets are used for deep wells*, they are often made to descend with their mouths upward, and made heavy to sink in the water. They have a valve in the bottom, which rises upward as the bucket sinks, but shuts again when the bucket is raised.

2962. *The Persian wheel* is a large wheel with buckets suspended from the circumference, but so swung that they always hang perpendicularly; of course, one half comes up full, while the other goes down empty.

2963. *The chain pump* is a very simple mode of raising water. It consists of a square or round barrel, placed perpendicularly. A chain is made to pass through this barrel, having on it a great many flat pieces of wood very nearly of the same shape and size as the inside of the barrel The lower end of the barrel being immersed in water, and the wheel turned round, the chain, with its floats or valves, forces up a body of water that fills the barrel. These pumps are found very useful on shipboard, and for draining ponds, and so forth. Sometimes stuffed cushions are used instead of the boards. This pump is often placed in an inclined position.

2964. *The fen wheel*, by which the extensive fens of Holland are drained, is a vertical wheel with floats round the circumference, like a breast wheel for grinding corn. Masonry or wood-work encloses one of the lower quarters of the wheel, so that when it turns round the floats bring up a body of water that fills the trough surrounding the floats. This is also used extensively in the fens of Lincolnshire and Cambridgeshire.

2965. *The bucket wheel* is like an overshot water-wheel, only moved round the reverse way, so that the buckets come up full.

2966. *The endless rope* is a most simple, but not a modern contrivance for raising a small quantity of water. A hair or soft hemp rope is made to pass over a wheel at top, and another at the bottom of a well. The rope is put in motion by a handle, and so much water adheres to it in rising that it is sufficient to make a constant small stream. To prevent the water from descending again with the rope, it is made to pass through a tube at the top to squeeze off the water.

Sect. XVI.—Supply of Water to London.

2967. No city in the world is so well supplied with water as the metropolis of the British empire is at present.

[This may have been correct when this sentence was penned, but not when this work was issued from the London press. The city of New-York, since 1842, by the comple-

tion of the stupendous water-works, which for several years have been in progress, has far transcended those of London, both in the purity of the water furnished to the population, as well as in the inexhaustible extent of the supply. The Croton River, 40 miles distant, has been brought, by spacious conduits and aqueducts, to ample reservoirs on the heights adjacent, whence it is conducted through iron pipes throughout the city, and by public hydrants is accessible, without charge, to the entire population. By its descent from the elevated reservoirs, it acquires sufficient head or force to supply public and private fountains, furnishing the citizens, at a trifling expense, with the introduction of it into their upper chambers, for baths and other purposes, while for the extinguishment of fires it is invaluable. The limits which restrict additions to this volume forbid amplification.]

2968. *At the time of the Norman conquest* London was supplied with water from the Thames on the southward side, and on the north of the river by several streams that took their rise on the high ground; the principal of these was the River Fleet, which was once clear and navigable, rising in Hampstead, but which, passing through a populous part of the town, became afterward so filled with impurities as to obtain the name of Fleet Ditch, and is now concealed from view by a vast brick arch, and converted into a common sewer, that conveys its muddy contents into the River Thames. There was another stream, called Wallbrook, that ran through London Wall, through the heart of the city, into the Thames; and a third, named Langbourn, from its great length, which passed through the spot where Fenchurch-street is now placed, and passed by Sherbourne Lane into the river; of these all traces have disappeared, the ground being entirely built upon. Towards the west, a stream called Oldbourne or Holborn, began at Holborn Bars, and ran into the River Fleet. Besides these there were several wells, the names of which remain in several streets, as Clerkenwell, Clement's Well, Holywell, &c.

2969. *Towards the end of the thirteenth century* London had increased so much that the Fleet River became too impure for the supply of water for domestic purposes, and the wells were altogether insufficient. The want of water, one of the first necessaries of life, was severely felt by those who were at a distance from the Thames, and this led to the forming of reservoirs, called conduits, in several places, to which the inhabitants could resort. The first that appears to have been erected was the Great Conduit, in West Cheap, called Cheapside, in 1285, the water to supply which is said to have been brought from Paddington. Many of these conduits were constructed between 1401 and 1610, being chiefly built over wells and springs. One was situated in Lambs Conduit Fields; another near the inn, named after it White Conduit House, and the remains of which existed a few years ago. A regular trade was carried on by persons called water-bearers, employed to convey water from the conduits to the respective houses, and sums of money were frequently left by "good and charitable people" for the purpose of keeping up these conduits; such importance was attached to them that they were put under the care of the lord-mayor and court of aldermen, who annually visited them in great state, to see that they were in proper condition—an occasion which formed a good excuse for a hunting-match and a dinner.

2970. *The conduits having been found insufficient* for the increasing demands, the idea was conceived of conveying water into London by an artificial river; but, although the citizens of London obtained an act of Parliament empowering them to cut and convey a river from any part of Middlesex or Hertfordshire, yet so difficult did such an undertaking appear to be, that it was not carried into effect; nor was a second act obtained in the early part of James I.'s reign more useful in advancing the project.

At length, *Sir Hugh Middleton*, a native of Denbighshire, citizen and goldsmith of London, who had amassed a large fortune by a mine in Cardiganshire, and who had been chiefly instrumental in obtaining the last act of Parliament, offered to the Common Council, on condition of their transferring to him their power under these acts, to undertake the work at his own risk and charge. This being agreed to, he commenced this work in 1609, but experienced numerous unforeseen difficulties through the art of civil engineering being then little understood in England, and from various obstacles through the proprietors of the lands in which the river was to pass. The City of London refused to aid him in his grand and useful design; and his own finances being reduced when he brought the water to Enfield, he would have probably been under the necessity of abandoning the undertaking, had he not petitioned King James himself, who, upon a moiety of the concern being made over to him, agreed to pay half the expense past and to come. The work was, in consequence, completed; and on the 29th of September, 1613, six years after its commencement, the water was let into the great reservoir at Islington.

Notwithstanding the successful accomplishment of this magnificent work, so little was the public sensible of its advantages for some time, that the original shares continued for many years at a small value; but such have been the profits from the project that the shares are now of immense value. To convey the water to various parts of the metropolis was attended with a great additional expense; but, notwithstanding the great benefit thus conferred upon the public, the once wealthy and public-spirited Middleton found himself, at the completion of the whole, a ruined man. Lady Middleton, his widow, received a pension of £20 a year from the Goldsmiths' Company.

2971. *Since that time various companies have been formed for supplying London with water from the Thames;* but complaints having been made of the great quantity of sediment deposited from the Thames water, much attention has of late been given to the subject of obtaining the water in a state of greater purity. No river water is superior to that of the Thames in general; but, when it descends below the bridges, it receives much impurity from the sewers which discharge themselves into it, as well as from manufactories and other sources, which have considerably increased of late. Filtration will, in a great measure, deprive it of its impurities; and, it is well known to those who have examined into this subject, the chemist will find it difficult to distinguish between water taken up at London from that procured higher up at Hampton Court, after each has been so purified.

2972. *A great number of Artesian wells have likewise been* made by boring through the London clay in London, from which a valuable supply is procured of very fine water; and it has been proposed to sink large shafts for the purpose of supplying the metropolis; but it does not appear that the quantity that could be raised in this manner would be sufficient, nor that the constancy of supply could be depended upon. Besides, as the water is now managed by the water companies, there seems little cause for complaint; on the contrary, no capital enjoys such abundance of fine water as London.

2973. *Much information respecting the qualities of the Thames and other waters* with which the metropolis is supplied has been obtained, in consequence of the experiments made by Dr. Bostock and other able chemists at the request of the parliamentary commissioners appointed to inquire into the subject. Dr. Bostock confirmed the observation that, when the Thames water was kept some time, a species of fermentation took place, on account of the animal and vegetable matter contained in it; inflammable gas was therefore disengaged, a disagreeable smell was given out, a scum rose to the top, and some impurities settled to the bottom. After some time, the water, by the separa-

tion of those matters, became more pure, and free from bad taste and smell, but containing more salts, and therefore harder than at first, which he considers was owing to the salts which had been contained in the organic substances, and which now remained dissolved in the water, in addition to what had been there before. The more foul the water, the more complete will be the depuration, since the fermentation is brought on by the organic matter; and hence we have an explanation of the popular opinion, which we have already mentioned, that the Thames water is peculiarly valuable for sea stores, its extreme impurity inducing the fermentative process, and thus removing from it all those substances which can cause it to undergo any farther alteration. The brown colour which this water often exhibits after its depuration is owing to a portion of what is called extractive matter, derived from decayed vegetable substances, and which is most abundant in the beginning of winter, when the heavy rains bring down much fallen leaves. This colour is not removed by simple boiling, nor by filtration through sand and charcoal; but a little alum or sulphate of iron boiled with the water threw down a precipitate, and left the water colourless. But this extractive, which stains the water, is not in the slightest degree injurious to health, which cannot be said of organic matter in a putrid state.

Much complaint having been made respecting the general quality of the Thames water, to satisfy the public, almost all the water companies not only now filter their water before they deliver it to the houses, but most of them take their supply higher up in the river than where the water can reasonably be complained of. The West Middlesex Company, in particular, take theirs as high up as Twickenham, and, by means of filtration, deliver it in a state of purity quite unexceptionable.

CHAPTER II.

ON FERMENTATION.

SECT. I.—GENERAL OBSERVATIONS.

2974. As several important processes connected with domestic economy cannot be satisfactorily explained, nor clearly understood, without adverting to the principles upon which fermentation depends, we propose in this chapter to give a rather full account of it; and we will endeavour to treat the subject in a familiar manner, so as to be intelligible to those who have little or no previous acquaintance with chemical science. Towards the end, we shall add some observations which, being explained only by chemical principles, may be less easily understood by the popular reader.

2975. *Various beverages, such as wine, beer, spirits*, &c., are the most remarkable products of fermentation; but the ordinary mode of making bread, the production of vinegar, and all the changes which animal and vegetable substances undergo, as well as the manner of checking and preventing those changes, and thus preserving food from decay, also depend upon the principle of this process. From this we may perceive how much the previous explanation of its nature will facilitate the study of several of the most important branches of domestic economy, by enabling us to distinguish the advantages and disadvantages attending particular processes which may have been recommended.

2976. *Animal and vegetable substances alone are capable of fermenting*; for though this term has been sometimes applied to natural changes in mineral bodies, it is incorrect to do so, since these substances are not susceptible of the peculiar chemical actions to which the name of fermentation is now restricted. We shall at present confine ourselves to the fermentation of vegetable substances, the products of which compose a particular class; and we shall treat, in a subsequent part of this work, of the changes incident to animal bodies, by which their decomposition or preservation must be explained.

SECT. II.—FERMENTATION OF VEGETABLE SUBSTANCES.

Although we have already described the chemical constitution of vegetable bodies in Book VII., Chap. VII., where we considered them as food, yet, in order to give a connected view of the subject of fermentation, it will be useful to repeat a few facts which we there stated. All the various kinds of vegetable substances, as fruits, grain, roots, in short, everything produced by the growth of plants, are composed of the same species of materials, but in different proportions; the elementary principles of which they all consist being carbon, hydrogen, oxygen, and nitrogen, but the last only in certain parts of vegetables and in small proportions. We likewise explained that these simple elements are supposed, first, to unite into what are termed the *proximate principles*, as starch, sugar, mucilage, gluten, lignin or woody fibre, and acids, together with various resinous and other matters elaborated by the organs of living plants.

2977. *While vegetables are living*, the elementary principles of which they consist remain united, and such internal motions and changes only go on as are essential to vitality, and the performance of their several functions. The vegetable takes in food from

the earth and the atmosphere; this is converted first into sap, from which are afterward elaborated the various secretions, as starch, gum, wood, &c., and the plant grows and increases in bulk by the constant accession of fresh materials.

2978. *But with the life of the vegetable, as with that of the animal, all the functions of nutrition and digestion cease,* and the organic body becomes subject to the laws of chemical attraction. The sap no longer moves through the several vessels; nor is it altered any more into sugar or into starch. The body, whether tree or herbaceous plant, being no longer itself part of the living world, passes into that state in which it becomes fit for the nourishment and support of animated beings. Even then it remains but a short time in the same condition; the minute atoms or particles of which it consists exhibit a strong tendency to separate from each other, and, finally, it is doomed to decompose. The proximate principles, sugar, starch, gluten, &c., are, under the influence of moisture, air, and warmth, resolved into the elements of which they are formed, oxygen, hydrogen, carbon, and, in a few cases, nitrogen, which, absorbing oxygen from the atmosphere, again unite into new compounds, as carbonic acid gas, carburetted hydrogen gas, aqueous vapour, &c. If these changes happen while the dead vegetable continues upon the surface of the ground, the new combinations, being gaseous, are volatilized, disappear, and mingle with the atmosphere; nothing remaining except a small quantity of carbon, which composes a part of the black vegetable mould, together with a minute portion of earths, alkali, and metallic oxydes that were constituents of the plant. It is to this natural decomposition that we apply the terms *decay* and *rotting* of these bodies.

2979. *But previously to this final destruction, or, rather, resolution,* of these substances by natural decomposition, the component parts of vegetables go through several very curious changes, in which they linger, as it were, for a while, before the final separation takes place; and it is to these alterations that we are now about to direct our attention.

2980. *Vegetable substances differ much in their tendency to undergo these changes.* Wood, for instance, which consists chiefly of ligneous fibre, will remain for ages without perishing: the same is the case with resin, camphor, and some others, though mixed with water; oils absorb oxygen from the atmosphere, and alter slowly into resins. On the contrary, starch, sugar, gum, and gluten, or substances containing them, if kept moist, very soon exhibit a disposition to change; a peculiar internal motion takes place, a degree of heat is excited, and the substances are said to *ferment.*

2981. In general, the pure proximate principles of vegetables alter but slowly by themselves. But it is when they are mixed together that the fermentation is most perceptible, and the change most remarkable. Thus, when gluten is added to a solution of sugar and water, the liquid soon runs into vinegar, or into alcohol and vinegar.

2982. The complicated parts of plants, in which the various proximate principles are already mixed by nature, especially the liquid parts, exhibit the finest specimens of fermentation; such as the sap of trees, the juices of fruits, the decoctions of leaves, seeds, &c. It is from such natural and artificial mixtures that we obtain all the products of fermentation which mankind has applied to useful purposes.

2983. *This fermentation, though frequently brought on by art, is, in fact, a natural operation,* and all that we can do is to put substances into the conditions necessary for its action. It is the result of laws established in nature, which we cannot alter in any degree. It is usual to consider fermentation as consisting of successive changes, forming so many *steps* or *stages* in the process, each of these products being extremely different.

2984. *The first stage is called vinous fermentation,* because it is that by which wine is produced; and it might with propriety have been called the *spirituous* or alcoholic stage, because through it alone spirit is formed, not only in wine, but in every other liquor containing spirit. *The second is named the acetous* fermentation, the result being acetic acid or vinegar; and *the last is the putrefactive* fermentation, because putridity is the consequence. These several stages usually follow each other in the order just mentioned. The vinous begins; and this, after a time, passes into the acetous stage, and that into the putrid.

2985. *There are but a few of the proximate principles of vegetables which are capable of undergoing the vinous fermentation: the chief of these are sugar and starch;* and we may perhaps say sugar only, because, when starch assists in the formation of spirit, it is supposed to be first changed into sugar during the process. This fact occasions a very striking distinction in vegetable matters, namely, those which, by possessing sugar or starch, are capable of affording fermented liquors; and those which, being deficient in these materials, cannot be so fermented.

2986. *Some chemists enumerate another species of fermentation,* which sometimes takes place, and precedes all these, viz., the *saccharine* fermentation, by which starch or fecula, and perhaps gum, are converted into sugar. Instances of this may be observed in the ripening or maturation of fruits, in preparing sugar from starch by an artificial process, and in the art of brewing. Still another species of fermentation has been mentioned, the *panary,* supposed to take place in the baking of bread; but this latter is now considered as only the commencement of the vinous fermentation.

Sect. III.—General phenomena observed during the fermentation of vegetables, and particularly during the vinous fermentation.

2987. If a saccharine vegetable juice, whether that of the grape or of any other fruit, or the decoction of malt, diluted with a sufficient quantity of water, be left to itself, at a heat equal to the ordinary temperature of summer, that is, from 50° to 70°, it will soon begin to *ferment.*

2988. *The appearances presented by this fermentation will be as follows:* A number of small air bubbles will rise to the surface and break; these will gradually increase in number, until the whole fluid will seem to be in a state of gentle ebullition. An internal motion in the mass will now be evident, and the liquor, though at first clear, will become turbid; the temperature will rise a little; a bubbling noise at length is heard, from the increase of the internal action, and the breaking of the air bubbles on the surface, and the liquor will have a tendency to swell so as to overflow the vessel. The gas or air which is generated, and which ascends in bubbles to the surface, not easily escaping, raises the fluid, and fills the upper part of the vessel; and, if it be examined, it will be found to consist mostly of carbonic acid gas, or fixed air. A lighted candle or taper will be instantly extinguished if held in it; and an attempt to breathe it would produce suffocation. This gas is heavier than common air, and, consequently, though invisible, it will be found to have flowed over the edge of the vessel containing the fermenting liquor, and to cover the floor of the apartment; and as, from its weight, it chiefly occupies only that part of the room, and does not mix readily with the common air, we are not always sensible of its existence, except we make some experiment to ascertain it. A dense froth filled with this gas now covers the surface of the fermenting liquor, and contains a viscid matter, in which it is entangled; the latter is called *yeast,* and has evidently been generated by the process which is going on. At length, after a few days, this action becomes languid; the formation of gas and of yeast lessens gradually; what has been formed of the latter settles to the bottom, and the liquor loses its muddiness, and becomes clear and transparent.

2989. *The liquor which has thus fermented will be found to have been very much altered in its properties:* its sweetness and viscidity have disappeared, and it has acquired a *spirituous* or a *vinous* taste and odour, evidently containing a quantity of *alcohol* or *ardent spirit:* hence this first stage is called the *vinous fermentation.* If the juice of grapes, called *must,* is the fluid that has been fermented, the product or new fluid will be *wine;* if it is a decoction of barley dried and made into malt, the liquor will be *ale;* and if either of these be put into the still, and heat be applied in the usual way, the spirit may be obtained, because, this being the most volatile part, will rise first as vapour in the still. This spirit, when deprived of much of its water by redistilling and other processes, will form *alcohol,* which is only another name for spirit perfectly pure. Pure spirit, or alcohol, whether derived from the distillation of wine, ale, even small beer, or any other fermented liquor, is of the same nature, and indeed absolutely the same liquid.

2990. *The first stage of fermentation always terminates in the production of more or less of the intoxicating fluid, alcohol;* and it is the proportional quantity alone of alcohol or spirit in any liquor which determines what is called its *strength.*

2991. *The explanation of this change* by means of fermentation, in which the sweetness of the liquor has disappeared, and alcohol has been produced, is this: the water remains unaltered, and it is the saccharine matter that has been changed into three new substances—alcohol, water, and carbonic acid. The decomposition has been effected by the chemical power of a certain substance called a *ferment,* a distinct principle from the sugar, and which either exists naturally in the juices of certain fruits, or in the yeast which is added to excite fermentation, as will be particularly described afterward.

It is necessary to observe that no vinous fermentation can occur in any liquid, except it contains a portion of both these principles, *sugar* and *ferment;* and it is only by the mutual action of these on each other that the process can take place.

2992. *But the natural operations by which the sugar is changed into spirit or alcohol, in consequence of fermentation, do not stop when this alteration has been effected;* for this is but the commencement of a series of changes which are to lead finally to its total decomposition, if nothing impedes it.

If the saccharine liquor, rendered vinous or spirituous by fermentation in the manner which has been just described, be exposed to the air in a temperature of about 75°, new changes, after a time, accompanied by a new set of phenomena, will take place. An internal motion will be again perceived; a hissing noise is again heard, occasioned by the disengagement of a little gas; and the temperature rises a few degrees. The liquid again becomes turbid; floating shreds appear on the surface, which partly collect into a sort of cake, and partly subside to the bottom. After this the liquor becomes transparent; but it is found that the spirituous or vinous taste has totally disappeared, and is succeeded by one that is extremely *sour.* In fact, the *acetous fermentation* has succeeded to the vinous, and the alcohol or spirit has been converted into *acetic acid* or *vinegar.*

2993. *If this vinegar be kept, not freed from much water, and for some length of time exposed to the air*, its acidity will gradually lessen, and at last disappear altogether; its surface will become covered with a mould that will increase into a cake, and, instead of the sharp acid taste peculiar to vinegar, the liquid will acquire a very disagreeable odour, and become putrid. This last change, therefore, is called the *putrefactive fermentation*.

2994. *We have stated that these three kinds, or, rather, stages of fermentation generally succeed each other* in the order which has been mentioned, viz., first the vinous, next the acetous, and, lastly, the putrefactive; but, perhaps, instead of considering them as entirely different species of fermentations, it is more correct to view them as the several parts of one great process; at the same time it must be observed that this rule of succession is not invariable. For instance, many vegetables become sour, that is, undergo the acetous fermentation, without any evident appearance of the vinous; and many substances pass apparently at once into the putrefactive stage. But these are cases where scarcely any sugar is present.

2995. *Certain conditions are necessary, in order that any of these stages of fermentation may take place:* 1, the presence of sugar, or some sort of saccharine matter; 2, a certain quantity of water mixed with the body to be fermented; 3, a natural fermenting principle, or the addition of yeast or some other ferment; 4, a moderate degree of temperature; 5, the presence of air. These several conditions we will proceed to illustrate.

2996. *We stated that sugar is the only substance capable of undergoing the vinous fermentation by which alcohol or spirit is produced.* Every modification of saccharine matter, such as honey, and sweet juices of any kind, can be fermented; and likewise all vegetables, such as carrots, beet-root, &c., that contain sugar; consequently, all substances of this kind will, by fermentation, afford spirit.

But sugar, as stated, will not ferment except it be dissolved in as much water as will make a thin liquid; and it is necessary that there should be much more water than is sufficient to form it into a strong sirup.

2997. *The phenomena of fermentation may be very conveniently examined and studied* by fermenting sugar. Place five parts of sugar with about twenty of water in a glass vessel, *a*, *fig.* 545, furnished with a bent tube, the extremity of which opens under an inverted jar, *b*, full of water; and, after adding a little yeast to the sugar, expose the mixture to a temperature of about 60° or 70°. In a short time bubbles of gas begin to collect in the vicinity of the yeast, and the liquid is soon put into a brisk motion, in consequence of the formation and disengagement of a large quantity of gaseous matter, which, passing into the vessel *b*, will be found, on examination, to be carbonic acid gas; the solution in *a* becomes turbid, its temperature rises, and froth collects upon the surface. After continuing the fermentation a few days, the evolution of gas begins to abate, and at length ceases altogether; the impurities gradually subside, and leave the liquor clear and transparent. The only appreciable changes which are found to have occurred during this process are, the disappearance of sugar and the formation of spirit, which remains in the flask, and of carbonic acid gas, which is collected in the glass vessel inverted over water. When the weight of the spirit produced and that of the carbonic acid gas are both added together, they are found to be very nearly equal to that of the sugar; hence it appears that the latter is converted into alcohol and carbonic acid gas.

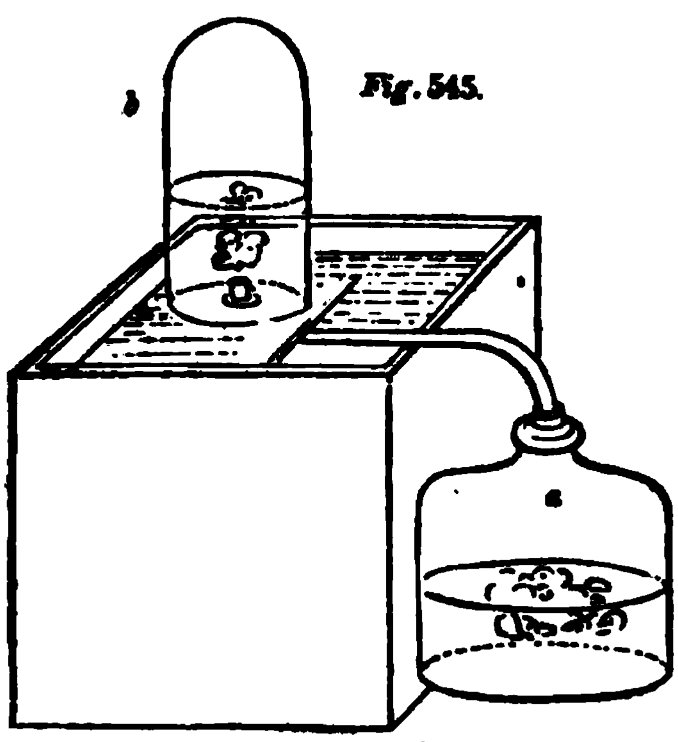


Fig. 545.

Bodies in a complete state of dryness cannot undergo any kind of fermentation. Though animal and vegetable substances, containing their natural juices, soon ferment, and, at last, putrefy, yet, if the moisture be entirely expelled by drying, they may be preserved for any length of time without change. This will be farther illustrated in Book X., "On the Preservation of Food."

2998. *We stated that the substance called the Ferment is a necessary and important ingredient in fermentation.* The researches of chemists have, perhaps, not yet satisfactorily shown what is the vegetable principle in which this property consists. It is generally supposed to be gluten; some, with less probability, have supposed it to be vegetable albumen; and, if not identical with one of these, it is evidently something very analogous. However this may be, it appears to be essentially necessary, as well as the saccharine principle, to the process, and both together frequently exist in vegetable juices. When that is the case, the juice will ferment *of itself*, if exposed to the proper degree of heat. The *must*, or expressed juice of grapes, is of this kind; to make it ferment nothing is necessary farther than to place it in the proper temperature, as it con-

tains naturally both saccharine matter and the proper ferment. Though we nave stated that sugar is the only substance that can afford alcohol by fermentation, yet it appears that *sugar perfectly pure* will not ferment by itself, and that the addition of some portion of ferment is essential. It is true that solutions of coarse sugars and sirups will ferment of themselves in warm weather, as the sugar refiners often experience to their great inconvenience; but these impure sugars contain a small portion of natural ferment in the other vegetable principles which exist in the raw sugar as imported; and our observation applies only to sugar perfectly pure, when refined. If a solution of fine crystallized sugar be suffered to repose and evaporate, it deposites crystals instead of fermenting; if it has been perfectly fine, the remaining sirup will not ferment; but if it has been imperfectly refined, the residuum contains some of the natural ferment, and it will run into fermentation.

2999. *All vegetable juices containing saccharine matter have also a certain portion of this natural ferment*, as well as the juice of grapes, the sugar-cane, and also the decoction of barley or of malt, and therefore they also will ferment of themselves; but most of these have so little of this principle that the vinous fermentation would take place very slowly, and often so slowly that the acetous fermentation would set in almost as soon, and vinegar, instead of alcohol, be the result; or it might even be the case that the putrefactive fermentation alone would appear.

3000. *It is the practice, therefore, to add an artificial ferment* to most materials, in order to bring on the process of fermentation more rapidly and effectually. In our description of the general phenomena which appear during the process, we mentioned a froth thrown up, called *yeast*, which is generated partly by the very process itself, though the elements composing it must have existed in the mixture; this has the peculiar property of acting as *artificial ferment*, that is, if added to any liquids containing the other necessary ingredient, saccharine matter, it will excite in it the vinous fermentation. Instead, therefore, of suffering the materials for the production of spirit to ferment of themselves, it is the practice sometimes to add to them a portion of the yeast which was produced by a former fermentation of similar substances. Thus, in the fermentation of wort, or the decoction of malt, in the brewing of ale, some yeast from a former brewing is added, not because the wort would not ferment at all without it, but because, in that case, the vinous fermentation would come on very slowly and imperfectly, and the liquor would soon turn sour.

3001. *There appears to be something peculiar in the ferment generated in each stage of the fermentative process:* thus, to produce the vinous fermentation, the yeast thrown up by another vinous fermentation is necessary. The matter deposited in the making of vinegar by the acetous fermentation is capable of acting as an acetous ferment; and it is well known that the putrefaction of flesh is hastened by being placed in the proximity of flesh already putrid. The acetous and putrefactive ferment, however, cannot, like yeast, or the vinous ferment, be procured in a separate form.

3002. *The nature of yeast is a subject of particular interest;* but, although it has been much studied by chemists, it is still imperfectly understood.

3003. *The yeast of beer, analyzed by Westrumb*, was found to contain, in 15,360 parts,

	Parts.		Parts.
Potash	13	Mucilage	240
Carbonic acid	15	Saccharine matter	315
Acetic acid	10	Gluten	480
Malic acid	45	Water	12,595
Lime	69		
Alchol	240		15,142
Extractive	120		

But it is obvious that all these ingredients in yeast are not essential to it as a ferment. From the experiments of the same chemist, it appears that, when the yeast is filtered, a matter remains upon the filter which possesses most of the properties of gluten; and that, when this substance is separated, the yeast loses its properties of exciting fermentation, but recovers it again when the gluten is added. The same thing happens when yeast is kept for some time: a white substance, not unlike curd, separates and swims upon the surface; if this be removed the remainder of the yeast cannot excite fermentation. This substance possesses many of the properties of gluten, though it differs in others; and it is generally considered to be that part of the yeast which is the active or real ferment. This apparently *pure yeast* has been analyzed, and it is found to consist of carbon, water, oil, ammonia, and carbonic acid.

3004. *An experiment of Kirchoff throws considerable light on the nature of yeast.* If pure starch be infused in hot water it is not converted into sugar; neither does gluten become saccharine matter when treated in the same way. But if a mixture of pure pulverized wheat gluten and potato starch be infused in hot water, the starch is converted into sugar. During the process an acid is evolved. The gluten is little altered in appearance, and if the liquid be filtered, most of it remains upon the filter. But it cannot be successfully employed a second time to convert starch into sugar. It appears, therefore, that it is some substance connected with gluten that acts on the starch and occasions this conversion.

3005. *Yeast, then, would appear, as we have said, to consist principally of a substance very similar in composition, and in many of its sensible properties, to gluten*, and when new or fresh it is inflated and rendered frothy by a large quantity of carbonic acid. When mixed with wort this substance acts upon the saccharine matter; the temperature rises, carbonic acid is disengaged, and the result is *ale*, which always contains a considerable proportion of alcohol or spirit. The quantity of yeast employed in brewing ale being small, the saccharine matter is but imperfectly decomposed; hence a considerable portion of it remains in the liquor, and gives it that viscid quality and body for which it is remarkable.

3006. *Yeast may be preserved by drying*. In large distilleries, where the required quantities of yeast are not easily obtained, it has been the custom to procure this substance from a distance; and in order to diminish the expense of carriage, the recent yeast has been put into bags to drain, and afterward has been compressed into solid cakes; or yeast may be preserved by dipping twigs in it and drying them in the air. This dried yeast is found, on trial, to excite fermentation in wort, but not so regularly as recent yeast; and a much larger quantity of the former than of the latter is required. Though dried yeast has been transported to certain distances, particularly in Germany, it has been found impracticable to convey it always in an effective state to India. In a warm, moist atmosphere yeast gradually putrefies, a sufficient proof that nitrogen forms one of its elements.

3007. *The fermenting property of yeast is weakened* by boiling for ten minutes, and is entirely destroyed by continuing the boiling. Alcohol poured upon it likewise renders it inert, on which account its power lessens as the alcohol is formed during fermentation. A thousandth part of sulphuric or acetic acid destroys its peculiar properties: a very small portion of sulphurous acid, or a sulphite, produces the same effect; so, likewise, do mustard, horseradish, and garlic. These substances are, accordingly, sometimes employed to check a too rapid fermentation.

3008. *When the juice of grapes is suffered to ferment by means of the natural ferment which it possesses, without the addition of yeast*, the saccharine matter of the fruit is decomposed during the process; a portion of this ferment is separated, and rises to the top in the form of yeast, while another portion falls to the bottom of the vessel, and is called *lees*. Both of these are chiefly decomposed ferment, which has already acted upon the sugar; but they still contain a quantity of the active and undecomposed fermenting principle, or leaven, and, consequently, can be employed as such in exciting fermentation.

3009. *What the natural ferment of grape juice consists of is not exactly known*; but from an observation by Gay Lussac it appears to require the addition of oxygen before it becomes active; for he observes that, if *must*, or *grape juice*, be heated to 212° in bottles, and corked immediately and carefully, it may be preserved without change, and be conveyed to any distance; but if it be exposed to the air only for a few seconds, it absorbs oxygen, and fermentation takes place.

3010. *Fermentation, once induced, will go on* of itself, if the temperature is sufficient, until one of the principles necessary—either the saccharine principle or the ferment—is exhausted: it will then stop; but it is a curious fact that the very process of fermentation itself occasions the production of a fresh quantity of ferment. If this generated ferment be separated, the process will not proceed so long as if it be continually mixed up with the fermenting fluid: hence the practice of breaking the head of yeast, and stirring it up with the mass, when it is required to prolong or renew the languid fermentation.

3011. *The fermented juice of the grape, and that of wort, or the decoction of malt, are essentially different*, although each contains saccharine matter and a natural ferment. The former will produce *wine*, the latter *beer*; but for the production of the liquor properly called *wine*, another principle besides sugar and a ferment is necessary. This additional principle is *tartaric acid*, which is always present in the juice of fruits, but most abundantly in that of grapes.

3012. *Sugar and tartar alone will not ferment*; therefore tartar cannot be the natural ferment, but the latter is contained in some other principle in grape juice, and probably not very different from the ferment in wort. If the experiment of fermenting sugar and tartar be made in a wooden vessel, they will ferment alone; but this experiment will be deceptive, for the wood supplies the ferment.

3013. *It is essential, also, to a complete fermentation, that there should be a just proportion between the saccharine matter and the ferment, or yeast*. If the yeast be in too great a quantity, there is a danger of the fermentation being too rapid, and that the liquor, after all the sugar is exhausted, should, by a continuance of the fermentation, pass into the acetous state: if, on the contrary, the yeast be too little, the fermentation will be too languid, too little alcohol will be produced, the whole of the saccharine matter will not be decomposed, and the liquor remain sweet. A perfect fermentation is when the whole of the saccharine matter and of the ferment are decomposed by their acting upon each other, being thus converted into alcohol. But it is sometimes desired to have the fermented liquor a sweet, vinous liquid. In that case the quantity of ferment must be less

than would be necessary to decompose the whole of the sugar, or the action of both upon each other may be reduced by some expedient, such as separating some of the ferment by a filter.

3014. *Fermentation probably commences somewhat sooner than it appears to do* by the bubbles of gas, which are the first indications; for the first carbonic acid gas that is produced in consequence of the process is absorbed by the water of the fermenting liquor, and it is only when the liquid is saturated that the gas escapes into the atmosphere with the appearance of effervescence.

3015. *A certain degree of temperature is essential to the process of fermentation.* Substances cannot ferment if exposed to considerable cold; the vinous fermentation cannot take place at the freezing point, or 32°; at 50° it is languid; at 60° it is quickened, and at 70° is so rapid that there is danger of its passing into the acetous; but, again, if the heat be much more considerable, yet below boiling, fermentation cannot happen; thus too low or too great a degree of heat prevents this process from taking place, or arrests it if begun. As the fermentation of beer does not succeed if the heat exceeds 77°, this beverage cannot be made in very warm climates, and very cold ones would require much expense to produce sufficient artificial heat.

3016. *The heat excited by fermentation is one of its most striking phenomena.* Its cause is entirely unknown, but an increased temperature is frequently one of the results of the decomposition of bodies. It will not begin until the temperature is raised to a certain point; and the heat excited by it is in proportion to the bulk of the fermenting mass, and the rapidity of the process. If the heat generated by the process, joined to that of the atmosphere, arise to too great a degree, it is necessary to restrain it, lest the vinous should pass into the acetous stage, and this is often found necessary by brewers and distillers. In the making of wine, strong must will bear a higher temperature than weak must, as the alcohol which is produced has a power itself in checking the fermentation, and also of preventing the acetic process; but in too high a temperature the juice of fruits that contain too little of the fermenting principle is apt to absorb oxygen, and to become sour; and this is often the case in the making of sweet wines. The larger the quantity of liquor, the lower the temperature may be at the beginning, as the process itself generates much heat. When the fermentation languishes from deficiency of heat, it is easily augmented by introducing a stove into the apartment where the process is conducted, or by heating a portion of the fluid, and then mixing this with the mass; agitation will diffuse an equal temperature through the whole. It is very important during fermentation to guard the fermenting vessel against any irregularities of temperature from change of weather or other causes.

3017. *The effect of air on fermentation was long disputed, but is now better understood.* It was once thought that no fermentation could take place in vessels absolutely close; and that the reverse practice, fermenting for a long time in open vessels, was productive of much injury and loss, partly from the evaporation of the alcohol as soon as it was formed, and partly by the yeast becoming sour and putrid, and communicating these properties to the wine, or other fermenting liquor. But the fact, as now ascertained, is as follows: if artificial ferment be used, a perfect fermentation will take place in vessels, however closed from air; but if the natural ferment only is present, as in the case of the mere juices of fruits, fermentation will not occur, as is shown by some experiments by Gay Lussac, which we shall describe, unless air be admitted.

3018. *Gay Lussac's experiments on the necessity of oxygen to excite fermentation are important,* as showing how small a quantity of it is sufficient. He took a bottle of the must of the grape, which had already been preserved more than a year by Mr. Appert's method of excluding the air, and was still perfectly limpid: he decanted this juice into another bottle, which was then closely corked, and placed in a temperature varying from 60° to 86°. In eight days it had lost its transparency, fermented, and was changed into a vinous liquor, frothing like the best Champagne. A similar bottle of juice, that had not been thus opened and exposed to the contact of air, although placed in the same circumstances, exhibited no signs of fermentation. He next passed a portion of juice into a vessel filled with and inverted over mercury, and added to it a small quantity of oxygen gas; and another portion of juice he confined in a similar vessel, perfectly freed from air. The former fermented in a few days, but the latter gave no signs of fermentation, even at the end of forty days. Similar results were obtained in experiments on the preserved juice of gooseberries; and he found the same thing to hold with regard even to the juice of fresh fruit. He passed some entire grapes into a vessel over mercury, and added to them hydrogen gas repeatedly, with the desire of removing all atmospheric air; the fruit was then broken down by passing a wire into the jar, and the vessel was left in a temperature of from 59° to 68°. At the end of twenty-five days it exhibited no signs of fermentation; but this process commenced the same day in juice to which a little oxygen had been added, and was also rapidly excited in the former portions when a little of that gas was supplied.

Grape juice could not be made to ferment when the air was *completely excluded*; but, on admitting a very small quantity of oxygen, this gas was absorbed, and fermentation

commenced, and continued independently of any farther contact of oxygen. But a solution of sugar, mixed with yeast, fermented even in closely-corked bottles, therefore without access of air; from which Gay Lussac concluded that there must be a difference between the natural ferment in the grape and the artificial ferment yeast. The application of these experiments is obvious, not only in the preparation of fermented liquors, but also, as we shall afterward see, in the preservation of vegetable and animal food.

Exposure to the air, therefore, or the presence of oxygen, is necessary to fermentation in the first instance; but it is only necessary at the commencement, and for a very short period; so that when once the process has begun, in the case of natural ferment or mere juices, it goes on in closed vessels: the reason of this is, probably, that the artificial ferment contains oxygen itself sufficient to begin the process, and in the case of natural ferment the very air contained in the wood of the cask is often sufficient.

3019. *It is certain that the carbonic acid which escapes during fermentation holds in solution a considerable portion of alcohol*, as is proved by a vessel of water placed near to the fermenting vessel absorbing alcohol, and being distinctly impregnated with it; and likewise by the intoxicating effect produced by the fermentative process on those persons who are much exposed to the fumes. The real loss of alcohol, however, from this cause, though important in a large manufactory, is not deserving of attention in domestic practice.

3020. *Several inventions have been made for fermenting in tuns* closed, instead of being open to the air, but their advantages are not very obvious, even in the large way, where the loss of alcohol may be considered as of most importance. Some suppose that the exclusion of the common air may prevent the liquor from passing into the acetous fermentation; but it should be recollected that while the vinous fermentation is going on, the whole surface of the fermenting fluid is covered with a stratum of carbonic acid gas, which effectually excludes the atmosphere; and it is only when the vinous fermentation has ceased that common air can come in contact with the liquor.

3021. *Fermentation is considerably influenced by the mechanical agency of the atmosphere, that is, by its pressure.* The pressure of the atmosphere retards it, and when that is removed it goes on more rapidly. If liquor to be fermented be put into a well-corked bottle, the fermentation takes place *in time;* but the process is very slow, because the carbonic acid formed during the process cannot escape; it is absorbed by the liquid as soon as it is formed, and this will go on until the liquor is thoroughly saturated with the gas; and then, there being no farther room for this gas, it cannot be generated, and the fermentation is suspended. Liquor in this state will be thoroughly impregnated with carbonic acid gas, and hence the briskness of bottled malt liquor. But if there be facility for the escape of the carbonic acid, the fermentation proceeds; and hence, if bottles are badly corked, the vinous fermentation continues until it passes into the acetous stage, the liquor becoming sour. In brewing in the large way, means have sometimes been contrived of regulating the rapidity of the fermentation by preventing, in some degree, the escape of the carbonic acid gas, and thus subjecting the fermenting fluid to the pressure of this gas.

3022. *The quantity of the fermenting liquor has also an effect upon the fermentation.* Chaptal observed that grape juice contained in a small cask did not finish its fermentation until the eleventh day, while a large tub, which contained twelve times the quantity, completed its fermentation in four days.

3023. *The temperature of the fermenting liquor is also influenced by the quantity.* The heat of the liquor in the cask just mentioned never exceeded 74°, while that of the large tub reached 94°. It is probable that the combination of the principles would be less perfect, and therefore the wine, on this account, would not be so good in the small vessel as in the large one; but the latter would have an advantage, that there being less heat produced, a smaller quantity of alcohol and aroma, upon which the excellence of the wine chiefly depends, would be lost by volatilization. The same observations apply to the fermentation of beer of any kind.

3024. *The fermenting liquor becomes specifically lighter as the fermentation proceeds*, a fact which is ascertained by an hydrometer, and this is called by brewers the *attenuation;* and they are in the habit of taking the specific gravity of the fermenting liquor frequently, in order to judge accurately of the degree to which the process has arrived, and regulating its management accordingly. The reason is this: the specific gravity of alcohol is much less than that of water, which forms the principal part of every fermenting fluid; that is, a certain quantity of alcohol will weigh less than the same bulk of water; of course, a quantity of alcohol and water will weigh less than an equal quantity of water alone, and the greater proportion of alcohol which the water may contain, the lighter the fluid will be. Now, as alcohol is constantly generating during the process of fermentation, it is easy to see that any certain measure of the fermenting liquor will get lighter as the process of forming alcohol proceeds.

3025. *The opinion we have stated, that sugar or saccharine matter is the only one capable of the vinous fermentation, may appear to be contradicted by some known facts.* Raw corn,

which contains much starch and but very little sugar, is, when mixed with malted corn, found to ferment, and afford as much alcohol as if the whole was malt. Also, alcohol may be abundantly obtained from potatoes, which contain much starch and scarcely any sugar, without any other preparation than boiling them in steam, breaking them into a fine paste with water, and adding a little raw wheaten flour and yeast. From these and similar facts it might appear that starch may at once be converted into alcohol by fermentation, as well as sugar. The observations by Kirchoff threw great light on this subject. He found that neither gluten nor starch, when kept in hot water separately, became sweet; but when a mixture of these two substances was put into similar circumstances, the starch was converted into sugar. Here it is plain, therefore, that this conversion of the starch was in consequence of some agency of the gluten. In the cases above alluded to, of raw corn and potatoes, there is some gluten present, by the action of which the starch might be changed into sugar; and a very small quantity of gluten as a ferment is sufficient to produce this conversion into sugar. The mode by which raw grain is converted by germination into malt, which is a sweet substance, is a similar process; and the production of sweet wort by the brewer or distiller from raw corn is another instance; so is the sweet taste of bread. As soon as sugar has been formed from the starch by this means, it passes so rapidly into the vinous stage that the state of sweetness sometimes escapes notice.

Thus it appears that not only do vegetables which contain actual saccharine matter produce spirit, but those also which contain starch can be made to undergo the vinous fermentation, owing to the starch being converted into sugar, which we know it is capable of by several processes; and that this newly-produced sugar goes at once, and as soon as formed, through the vinous fermentation.

3026. *The nature of ferments, we observed*, was yet little understood; but it would appear that various substances are capable of acting as ferments, or exciting fermentation of some kind. This property appears to be possessed in the highest degree by vegetable gluten and vegetable albumen; but caseous matter, fibrin, and gelatin, carbonic acid, &c., have also this power in some degree. But the substance which is usually employed to excite the vinous fermentation is the only one that has yet been studied with much attention, and it is much more rapid in its action than any other. That an acetous ferment exists is evident from the acetous fermentation being soon excited in a cask in which vinegar has been made.

ACETOUS FERMENTATION, BY WHICH VINEGAR IS PRODUCED.

3027. We stated that if liquids which had passed through the vinous stage of fermentation were exposed to the air for some time, in a temperature between 40° and 80°, a new change took place, by which the alcohol disappeared, and was succeeded by an acid taste in the liquor. During this change a slight intestine motion is perceived; the liquid rises in its temperature about 10° or 15°; it becomes turbid, and floating shreds appear, which subside at length into a gelatinous-like deposite. After some weeks it becomes transparent, and is found to be converted into vinegar, which consists of acetic acid, water, and some impurities. This acid has been generated by this new fermentation; the alcohol produced by the vinous fermentation has been decomposed into its elementary principles, and a new arrangement of them has taken place.

3028. *Every liquor which has undergone the vinous fermentation is spontaneously and necessarily disposed to the acetous.* Accordingly, every vinous liquor continually tends to become vinegar, and is actually changed into it sooner or later, according to circumstances, unless this change be prevented by some cause that is an obstacle to fermentation in general.

3029. *The acetous, like the vinous fermentation, requires a peculiar ferment*; andt his is supposed not to be very different from the vinous ferment, although its nature is very imperfectly understood: it would seem, likewise, to be some modification of gluten. The same yeast which excites the vinous fermentation in malt wort will also run the liquor into the acetous stage, if not prevented, but the matter which subsides in the making of vinegar is the most active in exciting the acetous fermentation. A cask in which vinegar has been already made will promote it, and fermented liquor can be converted in vinegar sooner in that than in another. But there is this difference between the vinous and the acetous ferments, that yeast, or the vinous ferment, is capable of exciting both the vinous and the acetous fermentations; but the proper acetous ferment can only excite the latter of these.

3030. *The theory of the acetous fermentation has been stated as follows:* during the process some carbonic acid is given out, which is supposed to be generated by the oxygen of the atmosphere combining with some of the carbon of the alcohol which is decomposed; and it is thought that vinegar, or the acetic acid, is formed at the expense of the alcohol. Alcohol by itself, as has been shown, is indestructible when pure; but when diluted with water, and mixed with vegetable matter, such as gluten, starch, sugar, or mucilage, it finds among these a ferment, which soon converts it into the acetic acid by a new arrangement of principles.

3031. *From these statements, we see that all substances capable of the vinous fermentation may pass into the acetous*, and do so naturally; but it would appear that some also acetify without apparently undergoing the vinous fermentation, and this occasions some obscurity in the theory.

3032. *Dr. Turner, in his System of Chemistry, has made a distinction that is very important.* The acetous fermentation, and the mere production of acetic acid, have been generally confounded together in books, whereas it is well known that although acetic acid is always the result of the peculiar fermentation that bears its name, yet this acid is often produced by the decomposition of vegetable substances, without any fermentation whatever. Mucilaginous substances, in particular, even when excluded from air, gradually become sour. Gum water sours without exhibiting any of the ordinary signs of fermentation. Weak ale, and beer, and wine, acquire acidity frequently, even in bottles well corked. These, and many similar processes, appear to be effected by a particular change of affinities, and are not attended by that visible movement in the liquid, with absorption of oxygen, disengagement of carbonic acid, and the other phenomena which accompany the acetous fermentation; to which we may add, that acetic acid is produced by the destructive distillation of vegetable matter in close vessels. The term acetous fermentation, therefore, instead of conveying the idea of taking in all the cases of the production of acetic acid, ought to be limited to the conversion of alcohol into this acid. That this change does really take place is inferred, not only from the disappearance of alcohol, and the simultaneous production of acetic acid during fermentation, but also from the quantity of the latter being precisely proportional to that of the former.

3033. *Of the three most important substances concerned in fermentation*, sugar, mucilage, and gluten, or the ferment, it would appear that the first is most disposed to undergo the vinous fermentation, and to produce alcohol; the second is extremely liable to change into the acetic acid, without apparently going through the vinous fermentation; and the gluten, if it does not act upon the sugar in producing the vinous fermentation, is most disposed, like animal matter, to pass at once into the putrid state.

3034. It would appear, also, that in some cases the acetous fermentation goes on, in a small degree, along with the vinous fermentation, and of course produces some acetic acid with the alcohol. This is evident in the distillation of malt spirits, where an acid is found to be left behind, which can have no other origin than the acetous fermentation, there being no natural acid in the malt. A part of this acid combines or unites with the spirit during fermentation; the other part remains behind, mixed, not combined, and such part as is more volatile rises with the spirit during distillation.

3035. *The presence of alcohol retards the acetous fermentation:* hence strong wines, and similar strong liquors, acetify with great difficulty, and bottled strong wines do not readily become sour. But when at last strong wines do acetify, they afford a stronger vinegar or more acetic acid than weak ones; however, in this case, the acid is not entirely supplied from the alcohol, for the mucilage of the wine contributes its share. Adding sugar during the souring increases, instead of diminishing, the quantity of acid.

Sect. IV.—Alcohol.

3036. We have mentioned that alcohol is the chief product of fermentation, and that it is the intoxicating principle in all fermented liquors; but it is never produced in a free state by this process. It is, at first, always mixed with water, mucilage, and some other of the constituent principles of the vegetable matter fermented, and from which it has been procured, as is the case with respect to wine, ale, or beer.

3037. *We likewise stated that pure alcohol is exactly the same from whatever vegetables it has been produced* by the process of vinous fermentation, all that is necessary being that they should contain saccharine matter. For this purpose, a vast variety of saccharine vegetable substances are employed in different parts of the world, each country making use of those which it has in greatest plenty, in order to produce a fermented liquor. Thus, in the south of Europe, the grape is chiefly used; in the East Indies, the juice of the palm affords an intoxicating beverage called toddy; in the West Indies, the sugar-cane supples rum; with us, malted corn is the chief material. After the alcohol has been formed by fermentation, another process is necessary to separate it in a pure state from the substances with which it is combined in the fermented liquor; and this process is *distillation*, for the nature of which, see Book VIII., Chap. VIII., Section 3, "Distillation."

3038. *When the produce of fermentation is distilled*, the spirit, being extremely volatile, rises in vapour, and is condensed by cold into a liquid: this, however, is not pure alcohol, for a quantity of water and other impurities rise with it. It is necessary, therefore, that this should be re-distilled, and go through other operations before it arrives at that state in which it is called rectified spirit, or common spirit of wine, the purest condition in which it is manufactured on a large scale. By another distillation it becomes *rectified spirit of wine*. But this still contains some water, which must be separated in order to obtain *pure alcohol*, which, however, is never employed in beverage; it is

only required by chemists for pharmaceutical compounds, or for experiments and other nice purposes.

3039. *The method which chemists usually employ to get rid of the water* to procure alcohol is to mix the rectified spirits with a quantity of carbonate of potash heated to redness to expel all its moisture. This salt has a strong attraction for water, and the greatest part of it is insoluble in alcohol. It, accordingly, combines with the water of the spirit; and the solution thus formed sinks to the bottom of the vessel, and the alcohol itself, which is lighter, swims over it, and may easily be decanted off; or, what is perhaps better, the solution of potash may be drawn off from below it by means of a stop-cock placed at the bottom of the vessel. The alcohol thus obtained contains a little pure potash dissolved, which may be separated by distilling it in a water-bath with a very gentle heat. What now comes over is alcohol very nearly pure. Instead of carbonate of potash, substances having a strong attraction for water may be employed to purify alcohol; for instance, muriate of lime. The specific gravity, as usually obtained, is 0·800; but by great care, alcohol has been obtained so low as 0·796, at the temperature of 60°, that of the least specific gravity being always the purest, as having the smallest quantity of water; equal quantities of water and alcohol constituting what is called proof spirit, the specific gravity of which is 0·917.

3040. *The properties of pure alcohol are the following:* It is perfectly colourless and limpid. It has a burning taste, and peculiar, rather agreeable odour. It is highly volatile, and it boils, or is converted into vapour, at 176°; consequently, it is easily separated from water by distillation, as the latter does not rise into vapour till heated to 212°. Like all volatile liquids, it produces a considerable degree of cold when any body is wetted with it, on account of its rapid evaporation: if the finger be dipped in it, on drying, the cold will be felt. It has been found impossible, hitherto, to freeze it with the greatest degree of cold that can be produced: it has been tried by a cold 91° below the freezing point without rendering it solid; hence it is employed for constructing thermometers.

It is highly inflammable, burning with a lambent, yellowish-blue flame; the colour varying with the degree of strength, the bluish tint prevailing when its strength is greatest, and the yellowish as it is weaker. Its combustion is attended by no smoke, the only products being water and carbonic acid. When burning, it gives an intense heat, though the flame is so faint as scarcely to be distinguished in daylight. It unites with water in every proportion; and the union is attended with a slight diminution of bulk and consequent increase of temperature.

It acts as a powerful solvent on many of the substances belonging to the vegetable kingdom; hence it is extensively useful in preparing liqueurs for the table, and in many processes in the arts. The principal substances which it dissolves are resin, sugar, manna, camphor, balsams, essential oils, the vegetable alkalies, tannin, and extractive matter. It also dissolves the deliquescent salts; but generally those insoluble in water are so in alcohol.

Most of the acids unite with alcohol by the assistance of heat, and form the substances called *ethers*. Albumen and muscular fibre are not dissolved by alcohol; on the contrary, they are coagulated, hardened, and contracted by it; and milk is speedily curdled by it. It likewise dissolves soap, wax, and spermaceti.

3041. *When analyzed, alcohol is found, in 100 parts, to consist of* hydrogen, 13·64; carbon, 68·18; oxygen, 18·18.

CHAPTER III.

BREWING.

SECT. I.—INTRODUCTION.

3042. *Brewing, or the art of preparing malt liquors,* was formerly considered as a more important part of domestic economy than it is in the present day, when the great increase of public establishments for this purpose has considerably diminished the necessity for private brewing. This, however, is chiefly confined to towns; in the country, many private families still brew their own beer, and there are many good reasons why this custom should still be adhered to.

3043. *In treating on this subject,* it might be perhaps expected that certain practical rules, founded on the best experience, should at once be laid down, exhibiting the perfection of the art. But, unfortunately, this is not possible. Not only are the best receipts for practice kept secret by professed brewers, but it does not appear that these are agreed among themselves respecting many important points. We are correctly informed by a writer in the "Library of Useful Knowledge,"

That the practical instruction for brewing ale and beer, as given by different "persons, are by no means uniform. The cause is obvious. The mode of manufacture, and, consequently, the quality, differ in every age and country; and, even in the same nation, the ale of one district has little resemblance to that of another." "He who has seen only one of the modes of brewing can have no conception of their number and variety. One shall mash three or four times, while another shall do so but once. A second shall pitch his tun at 80°

when others do so at 45°; the former cleansing in twenty-four hours, and the latter waiting three or four weeks for the finishing of the fermentation. One class of brewers attend chiefly to the attenuation, are minute in the heats of their fermentation, weighing the yeast with the utmost care; while there are many gentlemen (at the same time priding themselves on the goodness of their ale) who turn the worts into the barrels boiling hot, bung them up, and stow them for a year in their cellars, without any yeast at all. Each of these modes of brewing may be considered as producing a different species of ale; and each species has its varieties depending on natural or accidental circumstances, such as the water or the skill of the brewer, which add to its preservative qualities, and give certain adventitious flavours."

3044. *It is necessary, therefore, for every one who wishes really to understand the art of brewing to study its principles*, and not be contented with the mere routine practice of any one person or place.

3045. *With this view we have divided this treatise into two parts:* in *the first part* we shall describe the principles and operations of brewing, including a view of the chemical theory, as well as the general practice of the art, which we have kept together, so that one shall throw light upon the other: this we considered essential for those who are desirous of studying the subject scientifically. *In the second*, called "practical directions," we shall describe the practice only with all the minute particulars necessary to be observed. This separation we found necessary, since many persons may desire to see all the principal points to be attended to in practice, without going much into the theory; and had the whole been blended together, it would have been almost impossible to have distinguished the simple practical processes alone amid so much theoretical explanation; the theory would also thus have been encumbered with numerous fatiguing practical details. This arrangement has, indeed, rendered some repetition unavoidable; but we trust it will be found advantageous, although, without this explanation, it might have been thought unnecessary.

If the reader has perused with attention the article "On Fermentation," it will assist him much in comprehending what we shall say on this subject.

3046. *Brewing has been often practised successfully by persons who possessed no scientific knowledge*, and excellent beer and ale have been made in various parts of the country by our ancient dames, to whom the name of science was scarcely known. It might therefore be doubted whether there is any advantage to be expected by considering the subject in a scientific manner. The reply to this is easy. No theoretical knowledge can wholly supply the place of that which is the result of experience; but it may materially assist it, and more particularly with those who have had but little practice, to whom a work such as the present is chiefly addressed. An acquaintance with the theory of any process prepares the operator for his various operations, that may be regarded in the light of so many experiments, which, by this, he will understand and pursue with more certainty and intelligence. He is likewise by these means enabled to avoid many errors to which those unacquainted with principles are liable, and likewise the waste which they frequently occasion; an acquaintance with the scientific principles of an art renders the practice of more easy acquirement; and it is deserving of attention that the experience gained in this manner can be transmitted to others with greater facility. By connecting practice with theory, the latter being the knowledge of causes, an art is elevated, and may be rendered highly amusing, instead of its being, as it otherwise would, mere drudgery.

3047. Fifty years ago, brewing, both public and private, was in a very rude state. The first attempt to reduce it to scientific principles was made by a skilful brewer, Mr. John Richardson, to whom the art is much indebted, and to whose example we owe the present race of scientific brewers; but the modern discoveries in chemistry have likewise of late been successfully applied to the improvement of this art, which really involves some of the most curious and interesting phenomena in nature, and which has been considered to deserve the attention of some of our greatest philosophers.

3048. *It has been supposed that brewing on a large scale is necessary to produce good malt liquor.* This, however, appears to be an error; and though there are some difficulties in private brewing which are experienced in a less degree by manufacturers, yet there are some advantages in the former. Mr. Donovan observes that less heat is excited during the fermentation of small than of large quantities; and there is less danger of over attenuation, which renders the liquor liable to pass into acidity. When some of the fermentable matter is left unexhausted, it undergoes a slow and long-continued fermentation in the bottle, during which it mellows and becomes highly vinous. The great brewers, accordingly, have, in consequence, often fermented in small quantities; and Mr. Donovan, as well as other chemists who have paid attention to the subject, farther states that, from his own experience, malt liquors are best made in this manner in point of briskness, soundness, and body.

3049. *The economy or saving in domestic brewing* is, perhaps, not considerable; though, from calculations which have been published, the cost of beer should not be so great as when purchased from the brewer. But we are not to suppose from this difference in price that the brewer's profits are exorbitant; for he must have to pay for extensive premises, a very numerous establishment, and very costly apparatus; and out of this, too, the publican must have his profit. But economy is not the only advantage in domestic brewing. Good malt and hops are the only materials that we can depend upon,

in general, for making sound wholesome beer; and it is by domestic brewing alone that the genuineness of beer can be secured. There are many public brewers, no doubt, who use only the legal ingredients, malt and hops, in brewing; but it would appear that, before the beer or ale arrive at the consumer (unless common report in this instance deserves no credit), either improper substitutes are used in part for these materials, or some of the dealers adulterate these beverages; and it is well known that many of the articles employed for this purpose are of an extremely deleterious nature. Nothing is more usual than for persons to express their preference of *home-brewed beer*, which would not be the case were it not really of a superior quality. Home-brewed beer is, in fact, if properly made, excellent in every respect. It spontaneously becomes transparent, and requires no addition for fining: it is also particularly calculated for bottling.

3050. *It has been stated, very erroneously, that cottagers* and others could buy beer at a lower price than they could make it at, since large quantities are made cheaper than small. Here the brewers' and the publicans' profits have been forgotten; the labourer saves all these, and, besides, the women can do this work.

Before we proceed to lay before our readers the principles of the art of brewing, it may be useful to give a sketch of the general process.

3051. *Outline of the general Process of Brewing.*—The term *brewing* is confined to the art of preparing from grain the fermented beverages called *malt liquors*, such as *ale*, *porter*, and *beer*. Grain, of itself containing too little saccharine matter to produce the vinous fermentation, is made to go through a process by which the quantity of its sugar is much increased, and by which it is converted into *malt*, the substance from which the term malt liquor is derived. An infusion of malt is then made with water, at about 170°; this is termed *mashing*, and the extract so produced is called *wort*. This wort, containing much saccharine matter in solution, might now be fermented; but the produce of such fermentation, though it would contain spirit, and be a kind of ale, would very soon turn sour, on account of the great quantity of mucilage and starch in the liquor, which would pass rapidly into the acetous fermentation. To precipitate these substances, and thus destroy one of the chief causes of the injurious change which would otherwise take place, as well as to communicate a more agreeable flavour and taste, *hops* are boiled with the wort; the hops contain some tannin, an astringent principle, which, combining with the mucilage, causes it to coagulate and separate, thus enabling the beer to be longer kept; and they possess, likewise, an aromatic flavour, which they communicate to the liquor, and cover its sweetness. The wort, after having been impregnated with the hops, is now thrown into large shallow vessels, called *coolers*, where it is cooled to about 50° as quickly as possible, before it has time to get sour; it is then submitted to the process of fermentation, after having been mixed with some yeast, which, by the vinous fermentation, produces alcohol or spirit in sufficient quantity to give the required strength to the liquor; at the same time, a portion of undecomposed saccharine matter, and of the mucilage, still remain, and assist in giving the peculiar taste which is essential to constitute good malt liquor. But if the liquor was allowed to remain in the fermenting vat until the fermentation was quite finished, there would be great danger of its passing immediately into the acetous stage; therefore, as soon as it has fermented sufficiently, the new-made beer is transferred into barrels or casks with bung holes, in which the fermentation is finished in a slower manner. During this *slow fermentation*, which is technically termed *cleansing*, the remainder of the yeast works out through the bung holes, and some coagulated lees settle to the bottom, leaving the beer clear. If it be not then quite transparent, it is rendered so by the operation of *fining;* and sometimes it is racked off into other casks, or bottled.

3052. This sketch of brewing will prepare the reader for understanding the enlarged descriptions of the several processes which follow.

SECT. II.—MATERIALS FOR BREWING.

SUBSECT. 1.—*Malt.*

3053. Although in domestic brewing it might be thought sufficient to point out the qualities of the various kinds of malt as made by the maltster, since the preparation of it from barley is seldom attempted by private individuals on a small scale, yet, in accordance with the plan we have proposed to follow through this work, of teaching the *principles* as well as the practice of the various domestic arts, we feel it necessary to give a short account of the manner of preparing the malt, or, as it is called, *malting*.

3054. *The important part which saccharine matter acts in the vinous fermentation*, and, consequently, in producing the spirituous part of beer, has been already explained under the article "Fermentation."

3055. *Sugar of some kind occurs very generally in vegetables*, though not always in sufficient quantity to be recognised by the taste; and a small quantity is even discovered by the chemist in the farinaceous seeds, or corn. But, as we have shown, *starch*, called also *fecula*, is another very important principle, existing ready formed in vegetables. It is found in very large quantity in the farina or flour of various kinds of grain, particu-

larly wheat, and in certain roots, as potatoes, arrow-root, &c. It is a curious and interesting fact that starch is often converted into sugar by nature, and that this natural process can be imitated by art. We shall presently see that this change is effected during the time that the grains of corn begin to germinate or grow. The sugar of starch is, however, not so sweet as that of cane sugar, though equally capable of affording alcohol by fermentation.

3056. *We may perceive, from these facts, that sweetness alone is not the only test of a substance being fit for fermentation;* one that is not sweet, but which contains starch, can likewise be fermented. This discovery, which was made not many years since, has thrown great light upon some circumstances in brewing that otherwise would prove extremely puzzling, particularly that of the ready fermentation of unmalted barley. The fact is, that raw barley does contain a portion of saccharine matter, as is evident from its analysis; the use of malting is only to increase this quantity by a conversion of its starch into sugar, which actually takes place, as also during the process of brewing previous to the vinous fermentation.

3057. *Barley is the grain almost always employed in Britain* for the purpose of the maltster, being superior to any other corn we possess; but every kind of grain, with scarcely any exception, might be used upon occasion by the brewer.

3058. *The preparation of malt is chiefly to procure a cheap sort of sugar;* but the other principles in the barley also assist in giving their peculiar qualities to the beverages called *malt liquors*. The mode of increasing the saccharine matter in barley is by taking advantage of the process which nature always performs when seeds begin to germinate or grow; but, to render this intelligible, we must describe the nature of germination itself.

3059. *Seeds, when planted in the ground, will not germinate except there be moisture* and a certain degree of temperature, which must always be above the freezing point and below 100°; likewise, they must not be entirely excluded from air. The seeds of vegetables consist of two essential parts: the *germe*, that part endowed with the principle of vitality, and the rudiment of the future plant; and of the *cotyledons*, or *seed lobes*, which contain the matter designed to serve for the nutrition of the embryo, or young plant, in the commencement of its growth, and before it is able to extract nourishment from the soil; the whole is included under a skin, called the *cuticle*. In the germe two distinct parts are discoverable: the *radicle*, or little roots, which, in germination, descend into the earth; and the *plumula*, which rises upward, and forms the stem and young leaves. When seeds are planted, or placed in circumstances favourable for their germination, they absorb moisture and swell, the membranes which cover them burst, the radicle shoots downward, and, at the same time, we perceive it sending out minute vessels into the farinaceous part of the seed, for the purpose of extracting nutriment to supply the plumula, or young bud, when it begins to grow. This commencement of germination may be easily examined by pulling up seeds that have been lately planted, and a little before the leaves appear above ground; and they should be looked at in various stages of their growth. To see the minute vessels mentioned, which the radicle sends into the seed lobes, a large seed, as a bean, should be chosen; and the annexed cut will exhibit the appearance of it. *a b c*, *fig.* 548, is the external membrane, or cuticle; *d* is the radicle; *e*, the plumula: the substance within the cuticle contains the nutriment of the embryo plant, which is seen sending into it ramifying vessels.

Fig. 548.

3060. *A remarkable change at this period of growth takes place in the substance which composes the mass of farinaceous matter in the seed.* Though originally almost insipid, it becomes sweet; in fact, a large portion of the starch in the farina has been converted into saccharine matter, evidently for the nutriment of the young roots which have shot out; when these have acquired size and strength enough to find their way into the soil, so as to extract their food from the earth, and the young plumula appears above ground, this first supply from the farina is exhausted, and then nothing of the seed remains but the skin.

3061. *It is this very curious natural process, this conversion of the starchy matter of the seed of the barley into sugar* by the means of germination, that is brought on artificially in the art of malting, on which chiefly depends the preparing of fermented liquors from farinaceous grains.

Malting is, then, a method of causing barley to germinate when moistened and laid in a heap above ground, by which a great quantity of saccharine matter is produced; and after this, and before the young plant has begun to reduce the saccharine matter by feeding upon it, the process of nature is stopped through the application of a sufficient degree of heat.

3062. *The following is the process of malting barley:* Malting consists of four distinct operations, which follow each other in succession, *steeping*, *couching*, *flooring*, and *kiln-drying*. Barley intended for malt should be of the kind that is largest, heaviest, and thinnest skinned. It should be perfectly sound, but need not be of the fullest kind. It

should be all, if possible, of one growth, and not mixed, as grain of different kinds will not malt so equally together as if the whole was of the same sort. It is better also not to be quite new, but to have been in store for some time.

3063. *Steeping.*—The whole of the barley intended to be malted is put into a cistern lined with stone or slate, and water is poured upon it as many inches above the grain as it is expected to swell. The grain now imbibes moisture, and increases in bulk. A small quantity of carbonic acid is evolved, but does not rise in bubbles, as it is absorbed by the water, and may be discovered from the latter becoming milky if a little of it be mixed with lime-water. The steep water gradually acquires a yellow colour, and the peculiar smell and taste of water in which straw has been steeped; the barley at the same time becomes whiter, clearly showing that the water has absorbed a portion of the colouring matter that existed in the husk of the grain. Dr. Thomson observes that this yellowish colouring matter, when procured dry, by evaporating the water, has a disagreeable bitter taste, and contains a little nitrate of soda. This water is sometimes removed and replaced by fresh water.

After remaining in steep from forty to fifty-five hours, it is judged by the maltster to be sufficiently softened when the two ends of the grain can be easily squeezed together between the finger and the thumb. The water is then drained off, and the barley is removed to the malt floor to be couched. The increase of weight by steeping is considerable, but under twenty per cent.; when greater, the acrospire will have grown too much, and there will be a loss of saccharine matter.

3064. *Couching.*—It is now distributed on the floor in regular, rectangular heaps, about thirty inches deep, sometimes enclosed by boards, called *couch frames*, and in this situation it is allowed to remain for about twenty-six hours. If, some hours afterward, we plunge a thermometer among the grain, no increase of heat will be perceived; but at last the thermometer begins to rise, and the temperature of the grain will be observed to continue increasing until it is, on an average, about 10° above that of the atmosphere, which usually happens in about ninety-six hours; this increase of heat will be perceived by thrusting the hand into the heap. It now exhales an agreeable and peculiar odour, somewhat like that of apples.

The grain, which had become dry on the surface, now begins again to exhibit the appearance of moisture, called by the maltsters *sweating*, which is the first sign of germination. But it is requisite that this does not proceed too rapidly, which it would do were the heat allowed to increase still farther; and if the heaps were suffered to remain as at first, the heat would be greater in the centre than at the edges, which would cause the germination to proceed unequally. To prevent this, the maltster turns over the heaps with wooden shovels, and spreads it out in thinner heaps. The turning is repeated twice a day, and each time the heaps are made thinner and thinner, until at last they are reduced to three or four inches. The temperature which the maltsters wish to preserve is from 55° to 62°, according to the kind of malt they wish to make; but if not checked it would rise to 70° or 80°, and would at length actually char the grain.

But it is from the growth of the rootlets and plumula that the maltster ascertains when the germinating process has advanced as far as it is prudent to allow it. If we examine the grain soon after the commencement of the sweating, we shall perceive the roots beginning to make their appearance, at first as a white prominence, which, as it advances, divides into two or three, or more. These rootlets sometimes increase in length with great rapidity, even an inch or two in one night, except their growth be checked. About a day after the sprouting of the roots, the other part of the germe, the plumula, or embryo stalk, which is to produce the future stem and leaves, begins to shoot: this is called the *acrospire*. It rises from the same extremity of the stem with the root, and, advancing within the husk or skin, would at last (if the process were suffered to continue long enough) issue from the other extremity in the form of a green leaf; but, for the reason already mentioned, the malting is stopped before this takes place.

As the acrospire shoots along the grain to arrive at the opposite end, the kernel or mealy part of the corn undergoes a remarkable change. The glutinous and mucilaginous matter in a great measure disappears; the taste has become sweet, the colour white, and the texture is so loose that it easily bruises or crumbles to powder between the fingers, and this change is considered to be sufficient when the acrospire has come nearly to the end of the seed, and is just ready to burst out.

The object of the maltster is now accomplished; the farinaceous matter has become more soluble in water, much saccharine substance has been produced, which very readily undergoes the vinous fermentation. Before the acrospire has reached the end of the grain it is considered that a part of the fecula of the grain remains unconverted, hard, and insoluble; and if the acrospire be suffered to grow to a great length, then a portion of saccharine matter has been lost by the germination, having been employed as the food of the young plant. It may be observed that in the smaller kinds of barley, and in bere or bigg, it is considered that the acrospire should not be allowed to grow above three quarters or four fifths of the length of the grain, as more than that will diminish the saccharine matter. With respect to the actual nature of the change which takes

place, there is still some obscurity in the subject, and the best chemists are in doubt respecting it; it does not appear to be understood whether all the actual sugar is formed in malting, or whether much of the starch has only undergone such a change as disposes it to be easily converted into sugar by the hot water during the next brewing process, the mashing. The difference is very interesting in a speculative point of view, but less so in practice; for, however the case may be, we are certain that such a change is brought about by the process of malting; that barley which has been malted furnishes a decoction called sweet wort, much more capable of undergoing the vinous fermentation than one made from raw barley alone.

The time required for the grain to continue on the malt floor must vary with circumstances; the higher the temperature the sooner the germination arrives at that point when it must be altogether stopped by being dried in the kiln. In general, the operation of couching occupies fourteen days. In certain cases, where it is desired to have a milder but more viscid ale, the germination is not carried so far, and the time is shortened. Malting cannot be performed with any success in the summer months, and the best maltsters prefer cold weather; in winter they can always keep the germination at the rate they wish by heaping up the grain, whereas in warm weather it grows so rapidly that no effort can keep the process equal and regular.

3065. *Kiln-drying.*—By this process all farther vegetation is completely checked, and the malt is dried so as to enable the brewer to keep it for some time without injury. The mode of drying malt is a matter of great nicety, and there are various constructions of the floors of the kiln or chamber in which it is spread. Some are made of wire net-work or hair cloth; others are formed of earthen-ware tiles, or iron plates perforated with innumerable conical holes, very small at the upper surface, and much wider beneath. In the roof there is an aperture to permit the escape of the heated air and vapour. The malt is spread out on this floor about four inches in thickness, that it may dry equally; and beneath there is a large fire of charcoal or coke, the heated air from which ascends through the holes in the floor, passes up through the malt, and makes its way out through the roof, carrying the moisture along with it. The heat should be very gentle at first, not higher than 90°, and should be raised very gradually till it reach 140°.

Dr. Thomson informs us that he has seen malt dried at a temperature of 175° without becoming brown. The great secret in drying malt properly appears to consist in keeping the heat very low at first, and only raising it *very gradually* as the moisture is dissipated. It would seem that the less heat that is employed the better, so that the germination is completely stopped, and the malt is thoroughly dried, so as to keep well. The grain, which at first was hard and cohesive, has become friable like a mere body of flour, and is so easily divisible that, when properly managed, a mark may be made with the kernel like a bit of chalk. At the high degrees of heat sometimes used, much of the saccharine matter is decomposed and lost; and, in some places on the Continent, malt is at present dried only by the air without any fire. The degrees of heat employed give different properties to malt, and hence we have various kinds which are used for different purposes.

Pale malt is dried with the lowest heat, and its colour is not changed; it contains the greatest quantity of saccharine matter, and affords the strongest liquor; it is always used for ale, and now partly also for porter.

Amber malt is dried with a higher degree of heat, by which it is a little scorched; and it is less sweet, because some of the sugar has been a little altered.

Brown malt is still higher dried, and the scorching has gone so far that scarcely any taste of sugar is left. It is little used except for porter.

A malt of a deep brown colour, almost black, called *patent malt*, is prepared by roasting it in an iron cylinder in the same manner as coffee; the taste is very bitter, and its only use is to give colour to porter, for it is burned so much as to be incapable of fermentation.

The best fuel for kiln-drying is good coke or charcoal. Where it can be had, anthracite or non-bituminous coal is also used, such as the Kilkenny and Swansea coal, or culm: the fuel employed ought to give no smoke. Turf is used in some parts of Ireland, and this is best when prepared as coke.

When malt is sufficiently dried, it is suffered to cool slowly, and the sootlets are removed by screening; it is then spread out again to mellow, that is, to lose its crispness, and become soft and mealy, before it is ground in the mill for the brewer.

VARIOUS ADDITIONAL OBSERVATIONS ON MALTING AND MALT.

3066. So much of the knowledge and success in brewing depends upon the malt, that we shall enter into some farther details respecting the nature and properties of that substance.

3067. We are indebted for some of the following observations to Arthur Aikin, Esq., whose extensive knowledge of chemistry as applied to the arts renders his opinion highly deserving of attention: "In the conversion of barley into malt, a small quantity of carbonic acid is given off, and probably part of the starch is changed so as to become more soluble in warm water; the taste of malt is also sensibly sweeter than that of bar-

ley meal; and hence we may conclude that a portion of the starch is converted into sugar. A remarkable change also takes place in the texture or cohesion of the particles of the starch: in the raw grain they are compacted together, so as not easily to be broken down by the teeth, whereas grains of malt, when properly prepared, may be crushed with the greatest ease. The starch of wheat is soluble in water at the temperature of about 170°; that of barley appears to be soluble at perhaps a somewhat lower temperature. Now starch, when once dissolved in water, cannot be obtained afterward by mere evaporation in any other state than a hard, tough mass of difficult solubility, considerably resembling gum tragacanth. Hence it is peculiarly requisite, in drying malt, to apply at first a very gentle heat, for if, by an accidental forcing of the fire, or negligence in turning the grain, any portion gets heated to the temperature of 170° or 180°, the water and the starch immediately combine together, and no subsequent care in drying can prevent the grains so affected from becoming hard and perfectly useless to the brewer. Such grains, as well as those of raw barley, will sink in water, whereas those of well-prepared malt will float; hence our way of judging of the goodness of malt is to throw a little into water, and ascertain how many grains float and how many sink.

"If pale, well-dried malt be exposed to a gradually increasing temperature, it first becomes slightly yellowish brown, or pale amber-coloured; with an increase of temperature the colour increases, and, by proper care, it is very possible to bring the grains to a very dark coffee-colour without charring them in the least degree. In proportion as starch is charred, that is, converted into charcoal, it becomes insoluble in water, either hot or cold; but in proportion as it is exposed to an increasing temperature, provided such temperature is inferior to that required for charring, it becomes more and more soluble, and at last forms a perfect solution of the colour of clarified coffee, even when digested with cold water. This solution gives no indication with chemical reagents of the presence either of starch or of sugar; it will remain for months exposed to the air without becoming mouldy or turbid, and when evaporated, affords a brown gum perfectly resoluble in cold water. The sugar of the malt appears to be altered by heat before the starch is materially affected, and hence an infusion of brown malt is not sensibly sweet to the taste, and is not susceptible of fermentation."

3068. From this account it is obvious, that however the high drying of malt, so as to render it brown, may develop a soluble colouring matter, and a peculiar flavour, in the same manner as in coffee, and which forms some of the causes of the peculiarity of porter, yet it does this at the expense of the fermenting principle. Brewers have long ago found this out, and instead of using only malt dried *moderately brown* for porter, as was the case formerly, it is the general practice at present to employ *pale* malt for the purpose of the fermentation, and to add a certain quantity of *patent malt* for communicating the brown colour and flavour to which the public are accustomed in this beverage.

3069. The method of preparing the brown or patent malt was discovered by Mr. Wheeler, who took out a patent for it in 1817. The heat necessary to bring the malt to the degree of brownness proper for the required purpose is about 400° Fahr. Before the general adoption of this by the brewers, the operations of the maltster were considered of very great nicety in order to produce accurately the precise degree of drying necessary for various purposes; but the use of the patent malt renders the drying of malt an affair of much greater simplicity, as little more than pale malt is made in general.

3070. Malt that has been well dried by a long-continued low heat, not sufficient to alter its colour, and therefore called pale, will afford the most saccharine or fermentable matter, and, consequently, liquor of the greatest strength; it is also the only malt fit for brewing ale, since it does not give that acerbity of taste which is the consequence of rendering the malt brown, but which occurs in porter, and which porter drinkers prefer.

3071. According to Dr. Thomson, barley loses about 8 per cent. by being converted into malt, of which 1·5 is carried off by the steep water; 3 is dissipated on the floor; 3 consists of rootlets separated by cleaning; and 1·5 is waste.

The following is a comparison of the analysis of unmalted and malted barley, showing the changes that have taken place in the operation, particularly the diminution of starch and increase of saccharine matter:

Dr. Thomson.

	Barley.	Malt.
Gum	5	14
Sugar	4	16
Gluten	3	1
Starch	88	69
Total	100	100

Proust.

	Barley.	Malt.
Resin	1	1
Gum	4	15
Sugar	5	15
Gluten	3	1
Starch	32	56
Hordein	55	12
Total	100	100

3072. According to Proust, barley contains a peculiar principle which he has named *hordein*, and which has hitherto been confounded with starch; part of this hordein he supposes to be converted into saccharine matter, and part into a kind of starch possessing some properties different from the starch of barley: but this new view of the subject does not appear to be sufficiently established.

Malt may be preserved good, in a proper situation, for a whole year or more, if guarded from moisture; and it should not be too much secluded from air. If barley be subjected to the same temperature as in drying malt, it loses only 2 per cent., which is, probably, only water.

Excellent malt can be made from *oats*, which, when mixed with barley malt, affords a sprightly sweet drink; raw oats, well dried, not malted, would answer mixed with malt, and is permitted by the excise to be used in private, though not in public brewing. *Wheat* does not afford a malt so sweet as that from barley, and is not allowed in this country by the excise laws, but it is much employed on the Continent; in the Netherlands and Prussia they employ five parts of malted wheat mixed with one part of malted barley, particularly in making the white beer of Berlin. In India they make malt from *rice*, and the spirit produced from it is called *arrack*. The Chinese employ *millet* for a similar purpose. The malt from *rye* is said to afford more spirit than that from barley.

Malt is also made from *maize*, or Indian corn, and in the Philosophical Transactions we have an account of the mode of preparing it. It appears that it will not succeed in the usual manner, and that it must actually germinate in the earth. To effect this, the soil is removed from the surface to the depth of a few inches, and the maize sown quite thick upon the ground; the earth is then replaced over it, and in ten or fourteen days the shoots come up, and present the appearance of a green field; the germinating corn is then taken up, freed from the soil, and dried. This malt is very sweet, and makes a beer very pleasant and wholesome. Mungo Park informs us that in Africa the negroes prepare beer from the *Holcus spicatus*, and that the process which they employ seems to differ but little from that followed in this country; it is here worth recollecting that beer is said to have been invented by the ancient Egyptians. In all these cases it is obvious that the principle is the same; the germination of the various farinaceous seeds in malting produces sugar, the only material capable of the vinous fermentation.

The colour of liquors made from malt, when no colouring matter is used, arises from a degree of decomposition during the drying by fire; for if malt was dried in the sun, as it was formerly, the liquor made from it would be nearly colourless.

When malt is of the best quality, and well prepared, the grains should be large, clean, plump, well filled with flour, and not shrivelled, the skin thin. The grains should break easily when bitten asunder, and have a floury kernel that should give a trace like chalk: its taste should be sweet and mellow, and leave no impression of rawness, but should feel soft and mealy between the teeth, whereas raw grain is tough, and not easily broken: if the malt be hard and flinty, it is bad: the colour should be clear, and there should be no disagreeable smell.

Malt is specifically lighter than water, and will swim, but unmalted grain sinks. To try if the malt be properly made, put a handful of the unground malt into a basin of cold water; let every grain be wetted all over, and, if good, they will swim on their sides: such grains as swim endways, or sink, are not properly malted. If only 5 grains in 100 sink, the malt may be considered sufficiently good. A bushel of malt will weigh about 40 lbs., and the dealer should guarantee its weighing so much; what weighs less is not good; a sack will weigh about 160 lbs.; the value is therefore determined by its weight.

3073. *Grinding the Malt.*—Malt is ground previously to its being used for brewing. It is found best, in general, not to grind it to meal, but only so that each grain is broken or cut into three or four pieces. If ground to a fine powder, it is apt to set into a paste that the water cannot penetrate; and, except every particle of malt be exposed to its action, the whole of the soluble part will not be extracted. In large breweries the malt may be ground finer, because the whole mash is agitated by machinery driven by a steam-engine, and thus the mashing is performed quicker and more completely; but in brewing on a smaller scale, where the agitation cannot be so perfect, it is proper to grind the malt coarser, that the water may be allowed to act for a longer time, and the wort drain away through the interstices.

The usual method of grinding is by a common flour mill with two circular stones placed one above the other, but at a greater distance than for flour; but this grinds very unequally, some grains being reduced to powder, while others have the husks scarcely broken. Steel mills that cut the malt with teeth, in the manner of coffee mills, are much used, particularly in private families, and they answer rather better: they have the advantage of being always ready, whereas a corn mill may be found only at a distance, and private mills form a security against any unfair dealing with the malt. Their price varies from three to ten guineas, but, except great care be used, they are apt to grind too fine. Some use a pair of revolving rollers made of case-hardened iron for *crushing*, instead of grinding the malt, a method which some consider as superior, though it is apt to compress the flour, and prevent the action of the water. Whatever method most completely opens the husk, without reducing the kernel to flour, and allows the water to extract most completely the soluble part of the malt, will be best adapted for brewing. The malt should not be kept above a day or two after it is ground, as it is then apt to heat and ferment, and, consequently, to clot into hard lumps, that not only require to be broken, but communicate a bad flavour: but it is thought useful to keep it a day or two in a cool place, secluded from the light, to *mellow*, which, they say, renders the soluble part more easily extracted.

Subsect. 2.—*Hops.*

3074. *This essential ingredient in malt liquors* consists of the floral leaves of a well-known perennial plant, commonly called the *hop vine*, *humulus lupulus* of botanists. The hop is diœcious, that is, the male and female flowers grow upon different plants, and are

of a different form: the catkins, *fig.* 567, are picked and dried for the purpose of brewing. It is a native of Britain and most parts of Europe, and is seen occasionally flowering in our hedges in June, and ripening in September; notwithstanding which, its use in beer in England is not of great antiquity; when first employed here, it was introduced from the Netherlands. There is only one species of this plant, but there are several varieties of it, the qualities of which depend much upon the soil. The southern counties of England, particularly Kent, are celebrated for the mildness of their hops; those in the neighbourhood of Canterbury and Farnham are reckoned of the best quality for porter, uniting an agreeable flavour with strength. Nottingham hops, grown on clay, called *north clay hops*, are strong, but are thought to have a rather rank flavour; they are chiefly fit for liquor that is to be long kept. In Worcestershire and Cheshire a mild hop is grown very fit for ale. They are a very uncertain article of growth, frequently failing in bad seasons, a circumstance that has a material effect on the brewing of that year.

Fig. 567.

Hops are dried nearly in the same manner as malt. They are spread upon a hair cloth, from eight to twelve inches deep, and placed in the kiln, and a steady heat is applied for eight or ten hours, until the ends of the hop stalks are quite shrivelled and dry; they are then taken off and laid out on a large floor to cool. When quite cold, they are packed up in bags and sent to market. As the smoke from any fuel would be improper in drying malt, some kind that gives none is used, as coke, Welsh stone coal, or culm, or charcoal. If coal is the fuel, a contrivance called a *cockle-oast* is used.

3075. *Hops abound in a bitter principle*, which they possess in great perfection, and for which they are supposed to be chiefly employed; this is soluble in water, and is easily communicated to the wort in boiling; they likewise contain the *astringent principle, or tannin*, which is probably the most important one, by its precipitating the great quantity of mucilage contained in the wort, and which is the principal cause of beer turning sour. They contain also a *peculiar aromatic oil*, from which they derive the odour and flavour by which ale is distinguished, and which is very apt to be dissipated and lost by long boiling.

3076. *The ostensible use of hops in malt liquors* is the rich, aromatic bitter which they communicate, and which covers the sweet, mawkish taste of the liquor produced from malt alone, together with their power of preserving the beer from acidity. But there appear to be some doubts as to which of their principles this latter effect is to be ascribed. It appears to be an erroneous view of the subject to suppose that the preserving power of the hop resides entirely in the bitter principle; and hence to imagine that all bitter substances have a similar preserving power. It is the *tannin*, or *astringent principle*, that acts in this manner, by precipitating the mucilage of the malt; and many substances are extremely bitter without possessing tannin. Modern chemistry has likewise shown that there is no such thing as a uniform, unvarying bitter principle; but that the bitter of different vegetables is of a variable nature. Many of these are violent poisons. The cause of the bitter taste of the root of squills is very different from that of the hop; and many substances may communicate a bitter taste to liquor without having the power of coagulating mucilage, and thus preventing acidity. The bitter of some vegetables, instead of preventing acidity, is itself liable to become acid. On this account it is necessary to hesitate in admitting certain substances as substitutes for hops until the chemist has given us their analysis. At the same time, there is little doubt but many vegetables may be as useful in preserving beer, although they may not possess the peculiar aromatic flavour of the hop. Some of these will be mentioned in a subsequent part of our work. Dr. Paris states that "hops contain several elements of activity not in its substitutes. Its bitter principle is a tonic, its aromatic is warm and stimulant, and its astringent qualities precipitate the mucilage in the manner of tannin, and thus remove the cause of acid fermentation." Liebig is of opinion that the oil of the hops diminishes, in a great degree, the tendency of the alcohol to be converted into acetic acid, and therefore to preserve the beer.

3077. *The narcotic principle which they are known to possess* does not reside in the bitter, nor in the aroma, as some have supposed, but in a peculiar matter. A decoction of hops, like all narcotics, produces a little exhilaration, and is said to be stupifying; this effect is succeeded by depression. It is supposed that they add to the intoxicating property of the alcohol or spirit in beer, and the difference between wine and malt liquors in producing sleep is well known. It may be fairly doubted whether the constant use of a considerable portion of such a narcotic may not be prejudicial to certain constitutions, where exercise or much excitement is wanting to carry it off. Upon the whole, however, it is universally allowed that hops render malt liquors more wholesome than they would otherwise be, considering their great tendency to acidity.

3078. *Dr. Ives of New-York has discovered that the active principles of the hop do not reside altogether in the leaves of the flower themselves*, but chiefly in a fine yellow powder, which may be separated from the hops by beating and sifting. This powder, which he has called *lupulin*, forms about one sixth of the weight of the hops, and possesses the valuable properties ten times more than the leaves; it is well known to hop dealers, who call it *condition;* and they value hops in proportion to the quantity of it which they contain.

3079. *The best hops* are of a bright colour, between yellow and green; but if they are very green, they have been gathered too young; and when very brown, they have been allowed to ripen too long on the poles, or they are over-dried, and have lost their aroma, or peculiar flavour. They should have a powerful aromatic flavour, particularly when rubbed between the fingers, should feel clammy in the hand, and should possess much of the yellow powder above mentioned. Porter brewers prefer hops of a rather brown colour; but ale and table beer brewers use pale hops.

3080. *Hops do not keep perfectly good more than a year*, and therefore it is best to procure them of the present year's growth. They soon loose their essential oil, on which the aromatic flavour which they communicate to malt liquor depends; but they do not for several years lose their bitter and astringent principles. If they are more than a year old, but still fresh, they may, perhaps, require to be used in somewhat greater quantity: if they have not been well packed, they attract damp and become mouldy, in which case they are altogether useless. The close packing in bags is supposed to preserve them; old hops are generally reckoned to be one fourth or one fifth less in strength than new.

Subsect. 3.—*Water.*

3081. It is generally stated among the directions for brewing that it is absolutely necessary that the water should be quite soft, and that, if at all hard, it will not act sufficiently upon the malt, nor make good beer. Soft water, such as fresh rain water, or the water of a river or stream, is certainly the best, as being the purest; stagnant water is entirely unfit. But the hardness of water proceeds from certain salts which are dissolved in it (see Chap. I., Book VIII., "On Water"), and it does not appear that the small quantity of such salts is injurious to the process of brewing. Mr. Donovan states that "the grains and hops left after they have been duly infused in hot hard waters, repeatedly applied, are found to be perfectly exhausted of their qualities; and that as wormwood, gentian, quassia, and columbia give out their bitterness freely to water containing salt dissolved in large quantity, there is no reason for supposing that the same water would prove less efficacious with hops. It was formerly thought that good porter could not be made except with Thames water; but this is now known to be an erroneous idea. In fact, most of the principal London porter brewers do not use the Thames water, but have this liquid from deep wells which afford it soft, but still not so much so as that of the Thames. It may be considered, therefore, that many kinds of good drinkable fresh water will do for brewing, provided it be free from impregnations derived from stagnant pools or ponds containing decayed animal and vegetable substances. With regard to the objection that is often made to pump and well water, it is to be observed that these are not always hard; and when they are not so, they are generally very pure. An absurd notion has been stated by some persons that boiling bran in hard water will make it soft: this error arises from such persons not being acquainted with the theory of the hardness of water, or, in other words, with the true cause of that quality. We refer the reader here to Chap. I., Book VIII., "On Water," where he will find that salts alone are the cause of water being hard; and these cannot be in any way affected by the bran.

Sect. III.—Principles for the Operations in Brewing.

3082. We shall now proceed to describe the general processes employed in brewing, at the same time *explaining the principles on which they depend*, but reserving the minute practical directions for a subsequent Section.

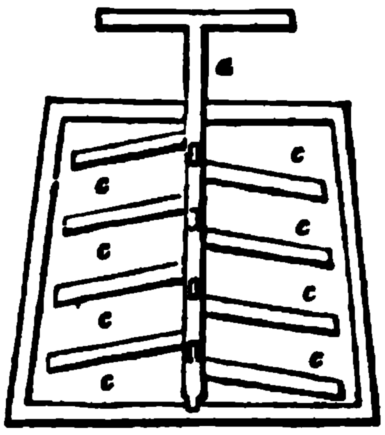
Subsect. 1.—*Mashing.*

3083. *The first operation in brewing is infusing in water*, or *drawing out the extract from the ground malt*, which extract is called the *sweet wort*, and contains all the saccharine and other soluble parts. This operation is termed *mashing*.

3084. *The heat of the water is a matter of very considerable importance;* but it is impossible to fix upon a degree that should always be employed without deviation, since the temperature must vary somewhat according to the kind of malt used, the sort of liquor required to be made, and various other circumstances which will be stated as we proceed. The heat of the water usually employed for mashing is from 160° to 180°, the best brewers generally using the lowest temperature. The water, at about this heat, is let into the mash-tub, and immediately after, the ground malt is let down upon it; or they are otherwise mixed, as will be seen in the description of mash-tubs. The malt being specifically lighter than water, it floats, and the whole requires to be well stirred together;

for if the malt were suffered to remain undisturbed, it would in time absorb water, and sink to the bottom, parting with its saccharine matter to that portion only of the water which is in immediate contact with it; hence agitation is found to be necessary for the purpose of bringing every particle of the malt into contact with fresh portions of water, and thus effecting a solution of the whole. This process was formerly performed in large, as well as in private breweries, by men who stirred up the malt in the water with long poles called *oars*, mixing the whole together in the most accurate manner, breaking all the lumps and clots, so that the water may have access to every part. In large breweries this operation is now effected by means of machinery. A vertical axis, *a b* (*fig.* 548), is fixed in the centre of the mash-tub, having horizontal wooden blades, *c, c, c*, projecting from it, which, being made to revolve, the blades succeeding each other break completely all the lumps, and prevent the malt from settling at the bottom. The saving of human labour by this means is very considerable, and the mashing is much more perfect. We have described this mode, which is one of the greatest improvements in the great breweries, not because it is absolutely necessary to do so, for it would very seldom, perhaps, be adopted in private brewing except on a very large scale; but because it is proper to know what is the most perfect mode of performing any process: the narrow wooden shovels, called oars, are all that are used in ordinary domestic brewing.

Fig. 548.



After the stirring has been continued for about three quarters of an hour, a cover must be put over the mash tun, to prevent the escape of heat, and the whole must be left quiet for the same length of time, about an hour or more, that the materials may react on each other, and likewise that the fine floury matter which had been mixed up with the water may subside; otherwise the wort, instead of being transparent, would run off muddy from the suspension of the fine particles.

3085. *It has been a common idea that during this time the water is merely taking up the soluble part of the malt;* but it is highly probable that another action likewise takes place, and that it is in the mash that a very large proportion of the starchy matter of the malt is really converted into that saccharine principle essential to fermentation, as we have stated already. This change appears not to be instantaneous, for the sweetness in the wort for the first ten minutes is inconsiderable, but it becomes gradually more and more so during perhaps two hours, notwithstanding the water is becoming cooler all the while.

3086. *Several facts appear to render it probable that the saccharine matter is not completely developed in the malt.* If cold water be left on malt for any length of time it does not become sweet, or very little so, and it will soon become sour; hence it is evident that the saccharine matter of malt is not soluble in cold water; but it is dissolved by hot water, and, once extracted by this, it remains always soluble, not only in hot, but likewise in cold water: it must, therefore, have undergone some change; and from this we see the necessity of mashing with warm instead of cold water.

3087. *Another fact proves that saccharine matter is formed in the mash tun* as well as in malting. It is now known that raw barley, if mixed with a certain quantity of malt, will give as sweet a taste to the mash as if the whole was malt, and can be made to ferment without being malted. This had long been secretly practised by the Scotch distillers of whiskey, with a view to evade the duty on malt, and, indeed, the expense also of preparing it. When the method was known to the brewers, it was resorted to by them also, producing an immense saving; but the practice was put a stop to by the excise. Private individuals are, however, at liberty to employ it for their own use. It is evident here that the effect produced upon a portion of malt is communicated to the starch of the raw barley, and this is supposed to be the result of a particular species of fermentation which we have already described as the *saccharine fermentation*. The formation of the sugar, therefore, begun in the malting, is completed in the mashing.

3088. *We shall now point out an accident to which mashing is very liable*, which it is absolutely necessary to guard against, and the nature of which cannot be comprehended without having recourse to those chemical principles which we are blending in our account. The accident to which we allude is called *setting* by brewers. When the water used for the mash is of too high a temperature, the whole often thickens and becomes of a pasty nature, which prevents the water passing through it, or the wort from draining off; in this case the whole mash is irrecoverably lost, the liquor remaining locked up in the paste. The cause of this curious phenomenon we shall now explain. We have already pointed out, that although the usual notion is that the whole of the starch of the barley is converted into saccharine malt during malting, yet that in fact only a part is so converted, and that, when the malt is ground for mashing, it still contains the greatest part of its starch slightly changed. Now it is a fact well known to every laundress that pure starch is not acted upon by water heated below 160°; but when the temperature of the water is raised to the boiling point, or nearly so, it then thickens

into a gelatinous mass, from a combination with the water, which is the state in which it is brought for stiffening linen. The accident of *setting* in the mash is exactly analogous to this. It is owing to the water being heated to such a degree as is capable of *gelatinizing* the starch of the malt, or converting it into a stiff gluey paste, which prevents the water from penetrating into the body of it; consequently, it cannot have access to and dissolve the saccharine part. The nature of this danger being clearly impressed upon the mind, it will be easily perceived that we must take care that the mean heat of the mash, when mixed, should not be too great, otherwise we shall run a great risk of setting; this heat should never exceed 185° at the utmost; at 198° most kinds of malt afford a cloudy wort.

3089. *But there are some other circumstances to be understood before we can be prepared against all the accidents* and failures which may arise from an improper temperature of the water used in mashing. It is evident that, if hot water be poured upon cold malt, that the temperature of the water will be at once considerably lowered; but it is found that this lowering is not so great as if the water was poured upon raw barley ground: the fact is, that some heat (that of a few degrees) is generated by the mixing together of ground malt and water, which does not take place when raw barley is used. Every one must have observed that heat is often excited by the union of two cold substances, an example of which is seen in mixing oil of vitriol with water suddenly. Now, in producing the proper heat of the mash, allowance must be made for all this; and that might be done accurately, did all kinds of malt give the same increase of temperature; but this is not the case, for the heating produced by the malt depends in some degree upon the manner of preparing it. High-dried malt heats more than pale; and malt heats more or less in proportion to the temperature in which it has been dried. The heating from pale malt is very little, and may generally be neglected; but that from brown malt is considerable, amounting sometimes, it has been said, to 40°.

3090. *Another evil attends too hot a mash*, namely, a portion of extractive matter is taken up by the wort, causing a degree of cloudiness, which often attends the liquor through all the subsequent processes, requiring at last the use of fining in order to be got rid of.

3091. *On the other hand, there are several evils accompanying* too cool a mash. The conversion into saccharine matter will be incomplete; much starch remains unaltered; the wort so produced will be deficient in flavour, and be apt to turn sour before it runs off clear. It is more difficult to preserve a proper heat in mashing a small quantity than a large one, because in the former the heat is soon dissipated, and the mash is apt to cool too much before the fermentable substance is extracted; hence it is necessary with small quantities to employ as much heat as may be consistent with other circumstances. Sometimes it is necessary to increase the heat of the mash, which may be done by pouring boiling water into a pitcher or tin pail, and immersing the vessel partly in the mash, but not so deep that the water can escape into it; the heat of the boiling water coming through the pail will warm the mash.

3092. *After the mash has continued* the proper time it is run off by a stop-cock, or spigot and faucet, into a vessel placed below to receive it, called the *under back*; this is, in the brewer's language, called *setting the tap*, a phrase probably borrowed from the old and simple fashion of letting off the wort from the mash tun by a tap tree placed in the bottom. This draining off the wort, which, if the brewing be considerable, is best effected by a stop-cock, requires to be done with caution, lest the grains in the mash tun should be disturbed, and choke up the holes in the bottom. To avoid this, which would prove very troublesome, and risk spoiling the brewing, the stop-cock should be opened at first very little, and care should be taken that the wort runs clear; if it comes off foul, what has been drawn should be returned gently into the mash-tub, and a little time allowed to elapse till it is found to run quite clear; as soon as this is the case, the whole, or all that is required, should be drawn off; but the clearness of the wort is essential.

3093. It must be observed, however, with respect to the term *clear*, that, with all the care possible, the wort never flows from the mash tun absolutely transparent and bright, but there is always a dulness, which is to be removed by the next operation, the *boiling*. The cloudiness which the wort sometimes will, after all, retain, is frequently, no doubt, owing to the water having been too hot, by which it has dissolved a small portion of the starch, inducing a slight degree of setting, which will be known by the wort having a slimy feel; but Dr. Thomson observes that some obscurity hangs about the cause of the occasional cloudiness of the wort, which sometimes, with every precaution, will continue all through the brewing, and which cannot be removed ultimately but by fining. The wort, as it first flows from the mash tun, will be, in general, of a fine amber colour; but its tint will depend upon that of the malt, pale malts giving light-coloured worts, and brown malts giving darker coloured.

3094. *Upon the whole, the actual temperature of the mash cannot be absolutely fixed by any precautions*, which renders brewing more uncertain than could be wished, and demands some experience where great accuracy is required. But observations such as the above must form the basis upon which experience should be built.

3095. *The whole of the extract of the malt is not obtained by the process we have just described*, some of the wort already formed adhering to the malt, which will still contain a portion of undissolved extract, which requires to be farther acted upon by the warm water, as in the case of tea or other infusions.

3096. *These second and third additions of water to the malt are termed the second and third mashings*. It must be evident that the strength of the ale or beer will depend chiefly upon the proportions of the malt and water, but partly upon the management, as well as upon the sort of beer to be made. The particular mode of adjusting the proportions of the materials and other circumstances upon which the strength depends will be considered in the "*Practical Directions*."

3097. *The first wort being drawn*, and put into the under-back, there are now several modes of proceeding, the choice of which will depend upon the kind of malt liquors required. If both ale and good table beer be wanted, the first wort alone may be reserved for the ale, as containing the most valuable extract of the malt, and the second and third mashings may produce the wort for the table beer, which is the usual practice; or these last two may be made into separate beers, the last being of very inferior quality. If it be required to make as much as possible of the best ale, then a certain quantity of wort may be still obtained from the malt of a quality nearly equal to the last, which may be added to it by the following process:

Pour, or, rather, sprinkle water, of the temperature of about 170°, on the surface of the malt in the mash tun, without stirring it, by means of a watering-pot having the holes in the nose larger than usual; or any kind of vessel, as a pail with holes in the bottom, may be suspended over the mash tun, and the water being poured into this, it may be moved about by hand and directed to every part of the mash. The tap hole of the mash tun being left open, wort nearly of the same richness as that at first obtained will flow, till the whole residue of the first wort which had been detained in the malt had run out. To know when to stop pouring on water, which should be done gradually, and at intervals, taste frequently the wort that runs out. When its sweetness diminishes greatly, which will take place almost suddenly, the tap hole is to be closed, and no more water is to be added. This wort is to be added to that already drawn. If any more water be added in the above manner, it will give a wort only fit for the table beer; its odour will be inclined to sourishness, although it be not, in fact, acid. This process is termed by the brewers *sparging*. But if it be required to make a good deal of weaker beer, as, for instance, table beer, then this last process may be omitted, and the second mashing gone on with immediately.

Before we proceed, it may be proper to mention that in the mash tun provision is made to prevent the malt which has been employed, now called *grains*, from coming off with the wort, either by a *strainer* in the inside, or by a double perforated bottom for this purpose, which will be described when we treat of the construction of the apparatus used in brewing.

3098. *Second mashing*.—There being still, as we have said, much of the extract remaining in the grains, warm water is again poured upon it in the mash tun, to make a second infusion. As there appears to be some difference of opinion with regard to the degree of temperature at which the water should be employed, it is necessary that we should resort to principles in determining this point. Richardson and other eminent brewers recommend that the heat of the water in the second mash should be 5° more than that of the first, and that of the third mash increased by 5° farther, raising the temperature in each succeeding mashing, in order to extract more from the malt. The reason for this is, in the first place, that all risk of setting is over after the first mash, and because it is desirable in the succeeding ones to obtain as much soluble matter as possible from the malt. But it has been observed by Dr. Thomson, Mr. Aikin, and other eminent chemists, that by far the greater part of the richest and most saccharine or fermentable part of the malt has been already extracted in the first mashing, which is reserved for the most delicately flavoured liquor; and that, although by this mode of proceeding, namely, increasing the heat in each mash, the second worts will acquire a greater specific gravity, yet that this gravity does not arise from saccharine matter only, but chiefly from starch and mucilage, substances which, when in excess, greatly deteriorate the quality of the liquor, and are liable to occasion failure by their turning acid. It is certain that the wort of the second mashing has but little sweetness, and a flavour and odour rather unpleasant than otherwise.

3099. *Third mash*.—The wort of the third mashing is of a greatly inferior quality, containing little else than mucilage, which, although by hopping may be made into a very indifferent small beer, is extremely apt to turn sour. Some, therefore, recommend that the water for the first mash should be 180°, that for the second 170°, and that for the third, if taken, 160°. With respect to the heat used in the first mashing, if it be too low, there is considerable risk of the wort contracting a sourness in the beginning of the brewing. In general, therefore, as Mr. Donovan admits, the higher heat is preferable. On these and similar subjects the judgment of the brewer must be exercised with reference to the object he has in view in brewing, and it is possible only to lay down principles for his guide.

3100. In great breweries, they sometimes make a fourth mash, but this is only used in what they call a *return*, which is merely used instead of water in the next brewing.

3101. *The whole of the kernel of the malt is never entirely dissolved by the hot water, even by the last mashing;* the husks, called *grains*, still contain a certain quantity, which is more or less according to the process, and form a nutritious food for cattle, pigs, &c. Grinding the malt finer would be favourable to a more complete extraction, but we have already stated the objection to this, from the difficulties of getting the water to pass through it in mashing without the aid of machinery.

3102. *The constituents of wort have been examined* hy Dr. Thomson, Professor of Chemistry in Glasgow. By evaporating it to dryness, he found that it leaves behind it a yellow-coloured residuum, which has a sweet taste, dissolves readily in water, and becomes clammy, in appearance much like treacle; this cannot be procured in a perfectly dry state. He considers it to contain a good deal of the peculiar kind of sugar called starch sugar, which is similar to the sugar of the grape, less sweet than cane sugar, and which cannot be refined, though it may be granulated like granulated honey. Like the sugar of grapes, it ferments without the addition of yeast. We have already spoken of mucilage and starch also existing in the wort. The presence of mucilage with some gluten is shown by their being precipitated in flakes by the addition of alcohol or astringent matter. The mucilage is very apt to turn sour, though a certain portion of it is essential to fine ales. The existence of some unaltered starch is proved by a solution of iodine dropped into the wort producing a blue colour.

SUBSECT. 2.—*Boiling and Hopping.*

3103. *The next operation in brewing is to boil the sweet wort*, prepared as above described, with the hops. The wort or extract from malt may be compared to the must or expressed juice of the grape, both containing a considerable quantity of the same kind of sugar; and, in fact, it would be possible to prócure a fermented liquor from the wort, either without addition, or only by adding yeast; but there are several important differences between the extract of malt and grape juice. Wort, besides being entirely deficient in the principle called *tartar* (which is found in the grape, and which will be mentioned when treating on wine), contains a much smaller quantity of saccharine matter, in proportion to the ferment. In consequence of this comparative abundance of the fermenting principle, if the wort were made to ferment at once, without boiling, as the juice of the grape does, it would very soon go through the vinous stage, and pass into the acetous, and, perhaps, the putrefactive; become *foxed*, as the brewers express it, and we should then, instead of beer, have only an ill-smelling vinegar, an effect which would be still farther increased by the large quantity of mucilage.

3104. *The chief use, therefore, of boiling the wort* is to get rid of some of this natural ferment, or gluten and mucilage, which are held in solution in too great quantity. This the boiling effects upon the principle of coagulation; for the gluten is coagulated or curdled by boiling water, in the same manner as white of eggs, and is thus easily separated from it. This coagulation, and likewise that of the mucilage, is farther assisted by the addition of the hops, which, containing an astringent principle, has a powerful property in coagulating these substances.

3105. *Another use in boiling the wort with hops* is to unite to the former the bitter and aromatic principles contained in the latter, which are necessary to cover the sweet mawkish taste of the sweet wort by itself, and give that agreeable flavour for which malt liquors are esteemed. It may, perhaps, be supposed that a decoction of hops might be added to the wort without boiling; but, as it is the boiling chiefly that effects the coagulation, this is necessary.

3106. *A third reason sometimes alleged* for boiling the wort is to evaporate part of the water, and thus render the wort stronger; but this is only in cases where too much water has been employed through error, or in consequence of bad calculation, which it is very desirable to avoid.

3107. *Wort, indeed, before fermentation, and after it, is extremely liable to acetify;* and this renders brewing an operation of great delicacy, slight circumstances being sufficient to mar its success, such as sudden changes of weather, or even thunder storms, to say nothing of the agency of witches, so much complained of in the olden time. The wort, therefore, should not remain long in the under-back, but should be transferred as quickly as possible into the copper to be boiled.

3108. *This coagulation, called breaking by the brewers, is generally accomplished* by boiling about half an hour, or nearly an hour, according to circumstances, and it is known to be sufficient by the appearance of flocculent masses swimming about and collecting in the copper; these gradually increase as the ebullition is continued, and they consist of the gluten and mucilage of the wort, which from the dissolved state have become solid by the combined operation of the boiling water and the astringent principle of the hops. When upon trial, by taking out a small quantity of the wort, it is found that the coagulation is complete, by the flaky masses subsiding to the bottom, and leaving the

wort clear, the boiling is discontinued, and the wort is drawn off, in order to be cooled previously to fermentation.

As a proof of the utility of this operation of boiling, it is noticed that, if a quantity of wort be fermented without being boiled, the fermentation continues much longer than an equal quantity that has been boiled, and that the first will produce a thin liquor that soon becomes acidulous, and which is not calculated for keeping. Such liquors were probably made before the use of hops was known, and were required to be drunk very new.

3109. *The boiling must always be continued till this coagulation appears*, otherwise it will be useless, and a much longer continuance of it is injurious; about half an hour may be sufficient for extracting the soluble principles of the hop, but not always for the coagulation we have mentioned. If the boiling be continued too long, certain evils ensue; too large a quantity of the coagulable ferment may be separated, and the presence of some of this in the wort is essential to the fermentation, which then will be languid; the strength of the liquor will suffer, and perhaps the whole may acetify.

Another evil is occasioned by too long boiling, and also by violent boiling, which cannot be easily remedied, namely, the loss by volatilization of the essential oil of the hops, which contains the aroma. On this account, the hops should not be put in until the wort has boiled some time, that the rank flavour may not be extracted by too long decoction; and care should likewise be taken that the boiling should be as uniform as possible.

3110. *The greatest part of the flakes coagulated is detained* in straining the wort into the coolers; what remains is thrown out with the yeast in fermenting, and lastly, in the lees of the beer, thus freeing it from matters which otherwise would have remained in solution, or have rendered the liquor thick and turbid.

3111. *In some places a separate infusion of the hops has been made*, and afterward added to the wort, instead of boiling the hops with the wort; this has been recommended, as preserving the essential oil, which is sometimes lost in the common process, and as leaving out the rank flavour which long boiling extracts.

3112. *Among the improvements in brewing*, some of which might be adopted in domestic arrangements where expense is not an object, is boiling the wort by means of steam surrounding the outside of the boiler, instead of suffering the fire to come in contact with it; this will prevent all risk of burning the ingredients, and giving a disagreeable taste to the beer. The boiler that supplies the steam should be furnished with a safety valve, and the outside jacket or casing, between which and the copper the steam is introduced, may even be of wood.

SUBSECT. 3.—*Cooling the Wort.*

3113. *After the wort has been sufficiently boiled with the hops, it is necessary to cool it down to the proper temperature for fermentation*; and this must be done as quickly as possible, since the wort would be very apt to pass into the acetous fermentation were it kept long at a high temperature. The necessity of cooling the wort *rapidly*, though so important, is one of the most difficult and uncertain parts of brewing, as it requires that conveniences are had for exposing a very large surface to the air, and it is necessary, also, that the temperature of the atmosphere should be sufficiently low, on which account it is not possible to brew well in the summer, nor in a warm climate.

3114. *Cool dry weather is best adapted for brewing*, on account of the cooling of the wort; extremes of heat and cold are unfavourable, and therefore spring and autumn have been generally selected for private brewing. March and October are months well known as the fittest times of the year. In the great breweries they brew some beer in the summer as well as in the winter; but then they make use of large fans and refrigerators for cooling their worts, and even with these there is more risk than in cold weather; in winter, with a dry north or east wind, the cooling is speedily performed; but in frosty or very cold weather the fermentation is slow, except means are taken to keep up the heat.

3115. *In warm weather*, especially if at the same time the air is moist and close, the cooling is so far retarded that spontaneous decomposition of the liquor sometimes begins to take place; specks of white mould sometimes make their appearance on the surface, and communicate to the mass a rank and disagreeable musty flavour. In this state the liquor is said to be *foxed*; and the effect consists in an extremely minute species of vegetation growing in the wort, but which it would require a good microscope to recognise. Should this accident happen, it would be sure to increase in every subsequent stage of the brewing, and even during the consumption of the ale or beer.

3116. *To expedite the cooling* as much as possible, a variety of expedients are resorted to, which must vary according to the magnitude of the brewing, and the particular localities. In dry settled weather the wort is best cooled out of doors, but it must be carefully guarded from rain. When it is cooled within doors, all the doors and windows should be set open, and it is necessary to take care that the sun does not shine upon it. Thundery weather is particularly unfavourable.

3117. *The temperature to which the boiled wort is to be reduced previous to fermentation ought, if possible, to be about* 60°, or very little more. The injury, however, sustained by fermenting at too high a temperature is not by any means so great as the least degree of foxiness; and therefore, if the weather be close and warm, and the brewer has no other means of cooling his wort except by exposure to the air, let him ferment at 70°.

3118. In Scotland and on the Continent they ferment at very low temperatures; but Dr. Thomson observes that, when the room in which the fermentation is carried on is cold, if the wort is cooled down as low as the atmosphere, it often refuses to ferment, and artificial heat is obliged to be used before it will begin. He recommends that the temperature should never be less than 56°, except the room be warmer, in which case the temperature may even be reduced to 52°. The wort loses during the operation of cooling a considerable quantity of water by evaporation. The loss in the cooling is often more than one eighth of the whole bulk of the wort; its strength, therefore, becomes greater.

Subsect. 4.—*Fermentation of Malt Liquor in the Tun.*

3119. We now proceed to describe the principal process in brewing, that for which all that has hitherto been done is but preparatory. By this process the sweet mild decoction called wort is to be converted into a brisk lively liquor or *ale* containing a considerable portion of spirit. As the general principles of fermentation have been already fully treated of, we shall now only touch upon them as far as they are necessarily connected with our present subject.

3120. *We have said that a solution of perfectly pure sugar in water will not ferment of itself*, although one made with brown or coarse sugar ferments very readily. The sugar made from starch will likewise ferment of itself, and of course the saccharine matter of malt, as well as a solution of the sugar of grapes. In the general view of the fermentation of wort, therefore, we may suppose that the yeast employed might be omitted, because it is not absolutely necessary to this process, but seems merely to render the effect more certain and rapid, and consequently prevents the passage of the liquid into acidity, which almost always takes place when the fermentation is very slow.

3121. *In some of the counties in England it has always been a practice in private brewing to trust to spontaneous fermentation*, instead of employing yeast to begin the fermentation, as is the usual mode. Mr. Booth, who has seen this method, which appears not to be generally understood, informs us that when the wort is sufficiently boiled, it is put at once, boiling hót, into the casks, merely separating the hops without any clarification. In about forty-eight hours the fermentation is known to have commenced by the appearance of a froth or yeast which is seen to issue from the bung-hole. The quantity of yeast that comes out from the cask is not considerable, and in the course of eight or ten days the fermentation subsides. It is now found that the yeast, which has been forming all the while, has collected into a solid crust on the surface of the liquor, which has at last, in consequence of contraction as it cooled, shrunk away from the yeast, leaving a vacuity between the liquor and the crust; and it is said that this crust of solid yeast is of use in defending the beer from the air. This ale cleans by subsidence only, but requires to be kept for a twelvemonth before it is fit to drink. Only strong ale can be fermented in this manner, for weak worts would run into acidity before the vinous fermentation could be completed. A similar mode of fermentation is employed in Brussels and other parts of the Continent.

3122. *By far the most general method, however, in this country*, and which is considered as making the best and wholesomest malt liquor, is to commence the fermentation by adding to the wort a certain quantity of *yeast* procured from another brewing; and this is, accordingly, the method which we recommend, and which we shall now describe.

3123. *When the wort is cooled down to the proper temperature* by exposure in the coolers, which may be about 70° in temperate weather, according to some brewers, but with others as low as 60°, or even 50°, it is run into a strongly-hooped vessel, deep, and of a suitable size, called the *fermenting tun* or vat, or, as the brewers term it, the *gyle tun*. This should be larger than would be merely necessary to hold the wort, because a considerable increase of bulk takes place during the fermentation, in consequence of which the liquor would run over, except allowance were made for it. On this account its capacity should be one half greater than the bulk of the wort; and it should have a cover to exclude the air.

3124. *It may be proper here to recapitulate the leading facts which render this process of fermentation necessary.*

The vinous fermentation, or the production of alcohol or spirit, which forms the intoxicating part, or strength as it is called, of malt liquors, cannot be induced except through the medium of some kind of saccharine matter; and the use of malt is to supply a species of sugar, which, though not exactly the same as that of the sugar-cane, is yet equally fit for fermentation. A solution of coarse sugar in water, we have seen, will ferment of itself; but, to expedite this process, a substance called a *ferment* is added, which substance is contained in yeast that has been thrown up by some previous fermentation. When this ferment comes into contact with saccharine matter under favourable circumstances, a peculiar chemical action takes place, in consequence of which the sugar is decomposed or separated into its elementary constituents, and these are recombined in another manner, so as to give rise to two new substances, *alcohol* or *spirit*, and *carbonic acid*. The yeast itself is likewise decomposed; but the nature of

this decomposition is obscure, and we may disregard it; since the alcohol and the carbonic acid themselves make up the exact weight of the sugar, we may consider it alone as supplying the alcohol. The alcohol being the liquid which we wish to form, it follows that the more sugar is decomposed the stronger will be the malt liquor; and its strength will depend partly upon the quantity of saccharine matter, or, in other words, malt or grain, employed, and partly upon the success with which the fermentation has been effected, the latter resulting, in a great measure, from the skill of the brewer. The carbonic acid gas or fixed air, separated by the fermentation, escapes through the liquor into the atmosphere, producing the appearance of ebullition, from which the process derives its name.

3125. *Having recapitulated these facts necessary to be kept in mind, we proceed to state* that, the wort being now in the fermenting tun, a certain quantity of yeast is to be added to it; and it is essential that this should be fresh and of the best quality, for bad yeast may spoil the whole brewing.

3126. *When wort is to be fermented for strong ale*, it is necessary to procure yeast from ale of equal strength. Though strong ales cannot be fermented by the yeast procured from weak worts, yet the yeast of ale will ferment any weaker beer. Weak beer ferments rapidly, but the fermentation is soon over.

3127. *Though yeast can be kept, yet new yeast is more active than old*; and it is a curious fact that, if successive brewings in the same place are inoculated with the yeast of the previous fermentations, the yeast will sometimes at last degenerate, in which case a supply must be had from another brewery. Yeast is also liable to become putrid by keeping, like animal matter; and the smallest quantity of this, or the least tendency to it, will inoculate the whole tun with its bad condition.

3128. *The best yeast* is that which is collected at the top, and which has become a dense tough froth, formed when the fermentation has been a good deal advanced. What has fallen to the bottom, or the *ground yeast*, is not so powerful.

3129. *The proportion of yeast that should be used* cannot be the same exactly for all cases, for it must depend partly upon the quality of the beer and on the season: in most cases, a larger quantity of yeast will have the same effect as a higher degree of heat in exciting the fermentation, and a smaller quantity will be equivalent to a lower temperature; but, in general, a gallon for four barrels may be stated as a general rule when the wort is from 60° to 70°; if the heat be greater, something less may be sufficient. If the fermentation is too languid, more yeast must be added to revive the action, without which the beer will not only be deficient in spirit, but have a mawkish taste compounded of sweet and bitter, be apt to fret on a change of air, and be peculiarly liable to turn sour. Great care must be taken to blend the yeast intimately with the wort.

3130. *The whole having been well mixed, and the cover put on the vat, fermentation commences* in from three to five hours, according to the temperature of the mass. A few bubbles may be seen first rising in the wort, and these collect first about the sides of the vat, where they soon form a kind of ring or line of froth: this gradually increases in breadth, advancing by degrees towards the centre, the liquor generally becoming turbid. At length the whole surface is covered by this frothy or cream-looking substance, which increases with a low hissing noise, owing to the breaking of the numerous air bubbles and the escape of the carbonic acid gas which they contain, the nature of which has been already explained.

3131. *As the fermentation increases in activity*, the froth or yeast rises higher, and is elevated partially in little pointed forms called *rocks* by the brewers. The yeast, at first white, becomes yellowish, then brownish yellow, or, rather, streaks and little masses of that colour collect upon it; these darker parts contain the bitter principle of the hop, and when it is not desirable that this shall be retained, as is the case in fine ales, the brewer skims it off that it may not mix with the liquor. About this stage of the process the brewer perceives a peculiar odour, somewhat of a vinous nature, called by the workmen by the strange name of *stomach*; and this continuing to acquire strength till the process is finished, the experienced brewer judges by it partly of the success of his operation. The froth at length becomes of a firmer consistence, being composed of a more viscid and glutinous matter, and the bubbles do not break so soon, but form larger than at first. The whole head, after this fermentation has continued some time, begins to grow flatter, the formation of froth lessens, and the dense viscid substance which had floated by its means would fall into the liquor if it was not skimmed off. This is done sooner or later, as the brewer wishes the fermentation to continue or to cease.

If he is desirous of continuing the fermentation, he will sometimes beat back the yeast into the liquor, and mix them together, which operation is termed *rousing*. If he wishes to check the fermentation, or considers it sufficient, he will carefully remove the yeast by skimming it off to preserve it for another brewing. As soon as the head of yeast ceases to rise the first fermentation is complete.

3132. *When the yeast is first added*, the wort is turbid, and has scarcely any degree of transparency; but as the fermentation advances, a gradual deposition of opaque matter takes place, and the liquor becomes comparatively transparent, as well as specifically lighter, in consequence of the spirit produced.

3133. *During the fermentation in the tub the temperature of the liquor continues to increase* till it be a few degrees warmer than when it was first put in, but the precise increase depends partly upon the temperature of the liquor at the beginning, partly upon the quantity of it, and partly upon the heat of the weather. In very large breweries it is said to rise even 12° or 15°, but perhaps not a third of this in private breweries.

3134. *Any sudden check to the fermentation is very injurious*, often occasioning a cloudiness in the beer which nothing can remove, and this same thing happens by a change in the weather; such alterations will affect small quantities much more than large ones, and, therefore, changes will be serious in small brewings that will not be much felt in those on a great scale.

3135. *A few farther remarks on the difficulties of this process or part of the art may be useful.* The smaller the quantity of wort to be fermented, the less is the heat excited by the process, and, consequently, the slower the fermentation. If the fermentation does not begin soon enough, or is too languid, the fault may lie with the yeast, which may be in too small quantity, or its quality may not be good, in which latter case it may be necessary to procure some from another brewery, though this is an evil that should, if possible, be avoided. If the quantity is too small, more may be added, from which little inconvenience can arise compared with that of an imperfect fermentation. Sometimes sifting a little flour of malt all over the surface is of use. Too languid a fermentation may also be owing to the temperature of the wort not being sufficiently high: in that case plunging a pail full of boiling water partly into the wort will raise its temperature.

If the quantity of yeast be too great, or the temperature of wort too high, the fermentation will go on too rapidly, and there will be danger of its passing into the acetous stage: when this is the case, everything should be done that will check the fermentation by cooling or otherwise. A pail of cold water plunged into the wort may be tried; the doors and windows may be thrown open. Too much yeast is liable to render the beer what is called *yeast bitter*. High-dried malt does not ferment so readily as pale malt, since the starch has become a little altered.

3136. *With respect to the extent to which the fermentation is to be carried*, this will depend upon the kind of liquor to be brewed: in ales it is not desirable that all the saccharine matter should be decomposed and converted into alcohol, because they require other qualities besides strength; it is requisite that they should have a certain degree of sweetness and viscosity; therefore the fermentation must be stopped before all these are destroyed. On the contrary, in porter, which may be called a dry malt liquor, sweetness is not wanted, and the fermentation is carried to a greater length.

Since alcohol or spirit is lighter, bulk for bulk, than water, it is evident that the more spirit there is produced by the fermentation, the lighter the wort which is fermenting will become; this lightness, which marks the quantity of alcohol produced, and, of course, that of the saccharine matter altered, is called by the brewers *attenuation*; and when they speak of the attenuation being carried far, they mean that the decomposition of the saccharine matter has been effected so much. The weight or specific gravity of wort is greater than that of water, just in proportion to the addition of the malt extract; hence the brewer has a mode of measuring this strength by means of an instrument called a *saccharometer*, and by the same instrument he can determine whether he has carried the fermentation as far as he ought, by ascertaining how much lighter it has become. This brings scientific brewing to a much greater degree of certainty than it could attain without the use of this instrument, which is now universally employed in this country by professed brewers.

But in private brewing a small difference in the strength of malt liquors is of less importance than in a manufactory, where a great part of the profits may turn upon it. Neither is it to be expected that this practice could be employed generally in domestic brewing; and therefore we have not introduced the description of the instrument.

3137. *Nothing positive can be said with respect to the length of time during which the fermentation of ale lasts*, because it varies considerably according to the heat of the weather, and the degree to which the wort has been cooled down. In ordinary domestic brewing it is generally completed in from twenty to twenty-four hours; but may sometimes require two or three days. In Scotland, in the great breweries, they ferment very slowly; for ten or twelve days, and even a fortnight or three weeks, which is considered by some as a good practice.

3138. *A small quantity of sugar is added to the malt* by some brewers when they consider the natural sugar of the malt not sufficient. This proves sometimes a useful addition, and serves to increase the strength of the liquor without the risk of running into the acetic state.

Subsect. 5.—*Cleansing and Barrelling.*

3139. *When the fermentation appears to have, in a great measure, subsided*, by not throwing up any more yeast, it will still go on for some time, but in a much more quiet and less obvious manner, a few bubbles of gas rising occasionally. The liquor cannot become quite clear so long as this is the case, since loose particles of the dregs, or subsided yeast,

will continue to float about. There is still some fermentable matter remaining in the liquid; and the continuance of a languid fermentation would soon cause the ale to run into acidity if the wort were suffered to remain in the vat; the yeast which had risen to the surface would subside to the bottom, where part of it would be dissolved by the spirit of the beer, and it would communicate an unpleasant bitter, which is termed by the brewers *yeast bitter*.

3140. *A second fermentation is therefore necessary*, to get rid of the remaining fermentable matter; and this process is performed in casks or barrels, into which the new malt liquor is now transferred from the fermenting tun. This second slow fermentation is by the brewers termed *cleansing*, because the beer seems to be cleansed of much foul matter, which consists chiefly of mucilage and exhausted ferment, part of which subsides to the bottom, under the name of *dregs* or *lees*.

3141. *As the yeast works out of the casks*, it leaves, of course, a vacancy, which must be filled up daily by beer reserved from the fermenting tun; and when the discharge of froth has ceased, or nearly so, which will be in about a week, more or less, the bungs are to be put in, and well secured. A slight fermentation continues for some days in the closed cask; when this has ceased, the feculencies begin to subside, leaving the liquor quite bright and clear.

3142. Transferring liquor from one vessel to another, termed by the brewers *racking*, always forms a considerable check to fermentation, by getting rid of the sediment, or lees, which contains a great deal of the ferment. In this case, if the quantity of the liquor in the fermenting vat be so considerable as to fill several barrels, it is evident that the temperature will be reduced by its being divided into portions; and in cold weather this check is sometimes too considerable, since it is necessary that the fermentation shall still go on slowly in the barrels. When this is the case, brewers, a little before racking, *rouse* or stir up the yeast and wort, to revive the expiring fermentation, or even add a little yeast.

3143. *If all the previous processes have been well managed, the beer itself will absorb all the carbonic acid gas that is generated in the enclosed cask*, which will be retained by the drink from the mechanical pressure to which it is subjected; and this will constitute that appearance of briskness which beer should have when just drawn, a property owing to the sudden disengagement of the gas which has been pent up in the liquor. While remaining in this state, the barrels should occasionally be examined by opening the vent-peg a little, lest the gas should collect in too great a quantity, when the barrels might burst, an accident which has been known to happen.

3144. *In a few months ale is generally fit for use*, though some is kept for a whole year before it is drunk; and it continues to improve all that time, provided it has strength or body enough, and it is kept sufficiently cool to prevent its passing into the acetous fermentation. The slow fermentation is some security against this, since any change can be more easily watched.

3145. *It is essential that a certain portion of the saccharine matter shall remain unfermented*, that, by its slow fermentation while keeping, the liquor may be *fed*, as it is called; that is, supplied with slow and gradual additions of alcohol and of carbonic acid, to prevent that flatness and heaviness which would ensue from the loss of the latter principle. Should it happen that the beer appears to ferment too much after being barrelled, another racking may be found necessary. By repeated rackings the fermentative matter may be got rid of, and such beer at last become clear and transparent; it may, if bottled, remain for years without *coming up*, as it is technically called. The object of the brewer should be to produce an agreeable beverage, distinguished not so much for absolute strength, or quantity of alcohol, as for colour, flavour, transparency, liveliness, and power of keeping for a long time.

3146. *It is essential that the casks shall be kept well closed*, to prevent the escape of the fixed air that is formed, and the access of common air. We have stated that the slow fermentation in the casks is useful in forming continual small quantities of carbonic acid gas, and, as this is absorbed by the beer, the latter is always saturated with it; likewise, what little vacant space there may happen to be in the cask above the beer will be completely filled with the gas, even a little condensed, which will prevent more from being liberated, or even formed, because there is no space for it to expand in, on which account the slow vinous fermentation is long kept up, and so long as this does exist in any degree, the acetous cannot begin; but when the surface of the liquor is exposed to the common air, the carbonic acid flies off as soon as it is formed, and room is thus given for the formation of more; what remains, therefore, of the vinous fermentation to take place is soon finished, and then the acetous will begin; in other words, the liquor will turn sour. This effect may be easily perceived when a cask is tapped; for the beer, brisk at first, after a time gets flat, from the want of carbonic acid, and, if it is not all used quickly enough, what remains sours.

Bottling, the most perfect mode of preserving malt liquors, is, in fact, like putting the liquor into very small casks, where all the effects are exactly similar to those just described. See farther, on this subject, under "Bottling Beer," Sect. X.

Sect. IV.—Practical Directions for Brewing.

3147. *Having now given a general view of those scientific principles upon which the art of brewing should be conducted*, we proceed to lay down such plain practical directions as are necessary to be attended to. We have already pointed out how much brewing requires the knowledge of its theory; but it would be difficult, perhaps impossible, to draw from the mere theory of an art the best modes of practice, since these have been the result of long experience, not by one only, but by various persons. The following practical directions have been drawn from the best sources; but we have already stated that no rules can be laid down that can serve as infallible guides in all cases; and hence we would recommend the attentive perusal of the previous section. But as there may be many persons who may wish to brew their own beer, without having leisure or inclination to pay so much attention to the theory as may be required, we have endeavoured to render this section as complete a guide as possible by itself.

Subsect. 1.—*Explanation of Technical Terms.*

3148. *In every trade there are some terms peculiar to it*, consisting of the names of parts of the apparatus used, or of particular operations. These terms, called *technical*, are frequently unintelligible to those not belonging to the trade, and throw a sort of mystery over the whole practice. This, which is, perhaps, in some degree unavoidable, impedes considerably the diffusion of knowledge by creating a kind of *cant* language, which is sometimes resorted to for the purpose of concealing the processes.

3149. *It is very desirable that these terms, often very unmeaning, should be employed as little as possible*; but in the mean time we propose to translate the brewer's into the ordinary language, or, in other words, to give an explanation of their technical expressions.

Liquor.—This is always the brewer's term for water—a word which he never uses.

Pale malt.—Malt which has been exposed to slight heat only in the kiln.

Amber malt.—Malt which has been exposed to a degree of heat somewhat greater.

Brown malt.—Malt which has been dried so much as to change the colour of the grain a little.

Patent malt.—Malt that has been roasted like coffee.

Slack-dried malt.—Malt which has been dried in the kiln less than usual.

Grist.—Malt that has been ground for mashing.

Goods.—The brewer's term for the ground malt in the mash-tub.

Mellowed malt.—That which has been exposed to the air for some time, and which, consequently, has imbibed some water hygrometrically, in contra-distinction to that which is fresh from the kiln.

Backs are large vessels of any kind intended to hold wort. The term is probably a corruption of the French *baque*, which signifies the same thing.

Liquor back.—The water cistern to supply the brewery.

Liquor copper.—Copper for heating water.

Wort copper.—Copper for boiling the wort and hops.

Mash tun, or tub.—Vessel for infusing the malt.

Mashing oars.—Sticks for stirring up the mash.

Mashing machines are used in great breweries for stirring the mash.

Tap-tree.—A wooden shaft for stopping the hole in the bottom of the mash-tub.

Setting tap.—Letting off the sweet wort.

Under back.—Vessel to receive the wort when let off from the mash-tub.

Hop back.—The first vessel for the wort to cool in, where the wort is drained from the hops. This is also sometimes called the *Jack back.*

Coolers.—Vessels to cool the wort in.

Gyle tun, the *fermenting tun*, or *fermenting tub.*—The vessel in which the fermentation is carried on. This is also called the *working tun*, and by the great brewers *squares*, from their form.

Pitching the wort.—Setting the wort to ferment; applied particularly to the degree of heat; as pitching at 75°.

Working.—Fermenting.

Stomach.—A strange cant term used by the workmen for the spirituous odour perceived in fermentation.

Sparging.—Sprinkling hot water on the grains, to obtain more wort after the first has been taken.

Stillions.—Vessels to receive the yeast that drains from the barrels; this name is also applied to the supports of the barrels.

Store vats.—Large vessels for keeping malt liquor to supply customers from.

Entire gyles.—When there is only one kind of beer from the same malt.

Party gyles.—A name used by the excise for making two kinds of beer from one malt.

A gyle of beer.—The whole quantity made at one brewing.

Blinked.—A species of acetification to which beer is liable.

Foxed.—When specks of white mould form in the wort as it is cooling.

Yeast-bitter.—When too much yeast has been used, and the beer is rendered too bitter.

Racking.—Transferring beer from one cask to another, to get rid of the lees or sediment.

Lengths.—A term used by the brewer to express the whole quantity of one kind of wort made from a certain quantity of malt.

Making up lengths.—Making up the whole quantity of beer of a certain strength.

Coming up.—Beginning to ferment again.

Cleansing.—The second, or slow fermentation that beer undergoes in barrels before it is finally put into the casks.

Rounds.—Large vessels like hogsheads, in which brewers transfer the porter from the fermenting vats, to undergo the slow fermentation previous to its being put into the store vats.

Attenuation is the conversion of the sugar of the malt into spirit, and the consequent reduction of the specific gravity of the fluid in the fermenting tub from this change.

Briskness of ale or beer is that state in which there is a quantity of carbonic acid compressed in it, which flies off when exposed to the air.

Flatness is the want of the last quality.

Heaviness seems to be the same thing, but with more alcohol.

Fretting means a slight fermentation, by which the beer becomes again turbid.

Feeding the beer is managing so that there shall be some saccharine left to cause a slight fermentation, which gives an addition of alcohol and carbonic acid.

Rousing.—Stirring up the beer so as to excite the fermentation.

Heat at which the tun is pitched.—The temperature at which the fermentation is begun.

Return.—Water which has been put to the grains after all the wort has been run off, to be used for another brewing instead of water alone.

Subsect. 2.—*Description of the Vessels and Instruments used in Brewing.*

3150. There are certain vessels required in every brewery; but the exact kind will depend partly upon the opulence of those who brew, and partly upon the scale on which

the operations are to be carried on. When economy is not so much an object as to have everything very complete, considerable ingenuity may be employed in fitting up the brewhouse, for which many hints may be obtained from the practice of professional brewers. In smaller establishments more simple apparatus will be found sufficient, and in many cases it may be an important consideration to reduce these to the greatest simplicity possible, and to show with how little expense and trouble brewing may be effected. The several modes have their particular advantages, and every individual must choose the style of the various implements which best suit his circumstances and convenience. In our description of the apparatus, we shall include the cheapest as well as the most complete kinds for private brewing.

3151. *Copper.*—The water is heated in a copper fixed for the purpose, if the brewing be on a tolerable scale, or in a portable one if the brewing be very small; in short, the size of the copper must depend upon the extent of the establishment, and what is required. *Fig.* 549 is a copper set of the smallest kind. In the best arranged breweries, the copper and reservoir of water are placed at the upper part of the building, for the convenience of the liquids descending lower and lower, from one stage of the process to another, thus avoiding the labour of raising them up. But this great convenience, the advantage of which will be easily comprehended in following the various parts of the brewing processes, cannot always be obtained; and the mode of arranging the vessels must depend very much upon the situation. There is sometimes considerable difficulty in preventing the contents of the copper from burning, which, if it should happen, will give a disagreeable taste to the beer; an improvement has been employed in great breweries, of boiling by means of steam, which obviates this inconvenience.

Fig. 549.

3152. *The mash tub,* or *tun.*—This is the vessel which is to hold all the ground malt, or grist, and water enough to make the infusion of sweet wort for ale. It should be large enough to hold the whole of the wort of which the ale is made, and all the malt; there should likewise be room enough besides to mash in, which requires at least five or six inches in depth, that is, the liquor should not reach above five to six inches from the edge of the mash-tub. It is generally made of wooden staves fixed by hoops of iron or wood, *fig.* 550, or a porter barrel may be sawn in two to make this and the fermenting tub. All that is essentially necessary is to have a tub or other vessel capacious enough to hold the malt and water to be infused, with a contrivance at the bottom to let off the infusion, or sweet wort, into another vessel. For this purpose some have a cock fixed near the bottom; but in cheaper apparatus a spigot and faucet, *a b*, *fig.* 551, is found sufficient for those who cannot afford the other. This, in the common one, is merely driven tight into the hole in the lower part of the tun, and the peg takes out; but this simple contrivance has several defects which a cock is free from: the wood is apt to swell with the hot liquid, and then can scarcely be moved; also, in attempting to draw off the wort it will sometimes issue suddenly and scald the operator. An improvement is to have a screw cut upon the faucet, as at *d*. Sometimes, to keep back the grains, a basket, *e*, is placed within the mash-tub, into which the spigot and faucet is driven.

Fig. 550.

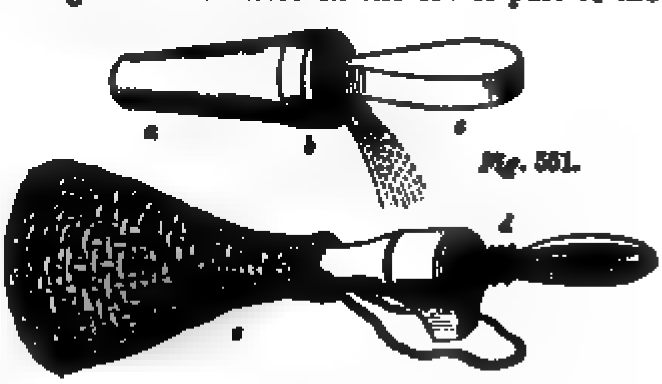


Fig. 551.

3153. *A simple and old method for the same purpose, used in many farmhouses,* is the following: In the middle of the bottom of the mash-tub, *a*, *fig.* 552, there is a conical hole, *b*, about two inches wide across, to draw the wort off through. Into this hole goes a stick called the *tap-tree*, *c*, a foot or two longer than the tub is high, and about two inches thick, and tapered for about eight inches upward at the end that goes into the hole, which at last it fills up as closely as a cork. Upon the hole, before anything else is put into the tub lay a little bundle of fine birch or heath, *d* (straw may do), about half the bulk of a birch broom, and well tied at both ends. This being laid over the hole, to keep back the grains as the wort goes out, put the

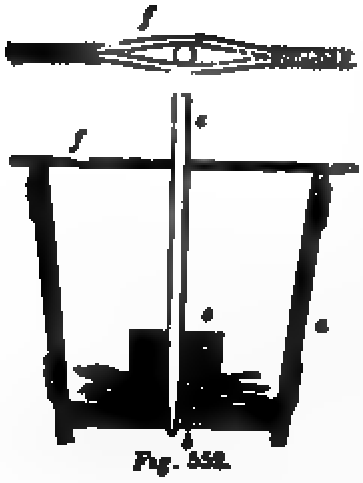
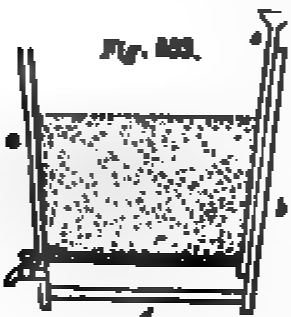


Fig. 552.

tapered end of the stick through the birch into the hole, and thus cork it up. To prevent the birch rising with the stick when you lift it up to let off the wort, a weight, *e*, must be placed upon the birch, and this is best done by making a leaden collar or ring, weighing three or four pounds, to slip over the stick, and slide down upon the birch. Some make shift with the iron box of a cart-wheel, but any contrivance will do that will prevent the birch from rising. To keep the stick at any height you may require, as you are drawing off the wort, the following method may be employed: Take a rod or branch of ash, hazel, or almost any wood, let it be a foot or two longer than your mashing-tub is wide over the top, split it down the middle, as for making hoops, tie it with a string at each end, lay it across the mashing-tub, pull it open in the middle, and let the upper part of the wort-stick come through it, as is represented at *f*. Now, when you raise that stick to let the wort off, let the split stick close upon it, and by its spring it will hold it up any height you wish: but this, though an old contrivance, is one which would scarcely be used if a spigot and faucet, with a wicker basket, which only cost eighteen pence, can be got; still, it is useful to know every resource. From this apparatus, brewers still term letting off the wort *setting tap*.

3154. Some recommend for a mash tun a vessel made in the following manner: A wooden vessel, *a b*, *fig.* 553, is provided with a double bottom, the uppermost one being pierced with holes. A pipe or trough, *c*, goes down from the top to the space between the two bottoms. The grist being put into the mash tun, water of the proper heat is poured into the pipe, and it descends into the space between *c* and *d*, and then ascends, by hydrostatic pressure, through the holes in the uppermost bottom, *c*, and, coming into contact with the grist, floats it, as the latter, when dry, is specifically lighter than water. In no great length of time the water begins to be absorbed by the malt, which then falls down. The use of the two bottoms is, that the wort may pass down into the space between them, and be drawn off clear, and the water is introduced below the malt, instead of the top, to avoid pressing the malt into the holes of the double bottom, and thus choking them up. The mashing tun is, in general, a little wider at top than at the bottom, though some prefer the contrary, that is, widest at the bottom, to prevent the grist from being compressed: it need not be quite so deep as it is wide across. The holes in the false bottom, if in wood, should be burned with a hot iron, and not bored, and should be a little conical, that is, wider below than above. The diameter of the holes at the upper part should not be above an eighth of an inch.

Fig. 553.



3155. As it is sometimes the case that a quantity of the grains of malt will get through the holes in the false bottom, which are difficult to get out, except this bottom be loose, some prefer the following contrivance: Four pieces of wood bored full of holes are nailed together in the form of an obtuse wedge, *fig.* 554, and this is placed over the hole by which the mash is drawn off. This simple apparatus stops the grains from passing out as effectually as a double bottom, and as it is merely put down loose, the difficulty just mentioned is obviated. It is necessary to state that this perforated wood must be fixed by a hook and eye, bolt, or some such contrivance, to prevent its floating. Its size must be proportioned to the quantity of the mash.

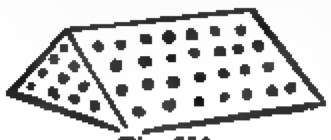


Fig. 554.

3156. *A strong stand, a, fig. 555, for the mash tun, b,* if large, is necessary: two stools may do for a small brewing. The stand should be high enough to admit of a tub standing under the mashing tun to receive the wort; but it should not be too high, or it will increase the labour of lifting up the water.

3157. *A shallow tub, called an under-back, c, fig.* 555, is placed below the mashing tun for the wort to run off into when drawn from the grains. Its size is proportioned to that of the mashing tun. It is best to be large enough to hold all the wort of one mashing, that the wort may not be cooled by being transferred into other vessels previous to boiling. But some make shift with it of smaller size, and collect the wort into the fermenting vat, until it can be boiled. In small brewings a good sized washing-tub will do very well.

3158. *A mash stirrer, fig.* 556, is a stick rather larger and stronger than a broomstick, with two or three small pieces of wood, eight or ten inches long, put through the lower end of it and sticking out on each side. Three or four sticks, of the size of broomsticks, may be also useful occasionally in stirring.

The size of the mash-tub must depend in some degree upon the mode of brewing. If one kind of beer be intended to be made at three mashes, for every firkin, or nine gallons of beer, the mash-tub should contain fifteen gallons. Thus, if two firkins of either ale or table beer be required, then the mash-tub must hold thirty gallons, and if one firkin of ale and two of table beer be wanted, the mash-tub must be of